1975

The operational impact of relocating Coast Guard Air Station San Francisco to Hamilton Air Force Base.

Snyder, Jean Andrew

Monterey, California. Naval Postgraduate School

http://hdl.handle.net/10945/20975

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

THE OPERATIONAL IMPACT OF RELOCATING
COAST GUARD AIR STATION SAN FRANCISCO
TO HAMILTON AIR FORCE BASE

by

Jean Andrew Snyder

June 1975

Thesis Advisor: S. H. Parry

Approved for public release; distribution unlimited.

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

THE OPERATIONAL IMPACT OF RELOCATING
COAST GUARD AIR STATION SAN FRANCISCO
TO HAMILTON AIR FORCE BASE

by

Jean Andrew Snyder

June 1975

Thesis Advisor: S. H. Parry

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Operational Impact of Relocating Coast Guard Air Station San Francisco to Hamilton Air Force Base		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; June 1975
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Jean Andrew Snyder		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE June 1975
		13. NUMBER OF PAGES 129
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Coast Guard

Data Analysis

Search and Rescue (SAR)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Coast Guard is actively considering the relocation of Air Station San Francisco to Hamilton Air Force Base. Presently located at San Francisco International Airport, the unit in question is the Coast Guard's major air facility on the Pacific Coast. Its aircraft allowance includes the HC-130 long-range search aircraft, the HU-16E amphibious search plane and the short-range HH-52A rescue helicopter. Relocating to Hamilton,

which is situated in Marin County near Novato, California, would represent a move of approximately 28 miles to the north.

It is the purpose of this paper to:

(1) Examine the proposed move from an operational standpoint;

(2) Through accepted techniques of quantitative analysis, develop a methodology to determine the effect of the move on operations; and

(3) Provide statistically significant conclusions which can be used by management as an aid in making the decision concerning the move.

The Operational Impact of Relocating Coast Guard Air Station San Francisco to Hamilton Air Force Base

by

Jean Andrew Snyder
Lieutenant Commander, United States Coast Guard
B.S., University of Texas, 1964

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
June 1975

ABSTRACT

The Coast Guard is actively considering the relocation of Air Station San Francisco to Hamilton Air Force Base. Presently located at San Francisco International Airport, the unit in question is the Coast Guard's major air facility on the Pacific Coast. Its aircraft allowance includes the HC-130 long-range search aircraft, the HU-16E amphibious search plane and the short-range HH-52A rescue helicopter. Relocating to Hamilton, which is situated in Marin County near Novato, California, would represent a move of approximately 28 miles to the north.

It is the purpose of this paper to:

(1) Examine the proposed move from an operational standpoint;

(2) Through accepted techniques of quantitative analysis, develop a methodology to determine the effect of the move on operations; and

(3) Provide statistically significant conclusions which can be used by management as an aid in making the decision concerning the move.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. THE INTRODUCTION

Although there is a saying that nothing is certain but death and taxes, a third very important factor--change--seems to fit equally well. The Coast Guard, like almost all other organizations, is currently experiencing its share of this difficult-to-plan-for inevitability. With a major shift in national interest to the environmental and conservation problems of today, the Coast Guard has found itself with several new responsibilities of primary significance. These include prevention, detection and cleanup of pollution, and the enforcement of various laws and treaties concerning our natural resources in the sea. An almost certain result of such changes, coupled with the continued growth of older missions (such as search and rescue), is the requirement for more resources with which to perform the work. In some instances, a new shore station must be built where there had been no previously identified need. In other cases, obsolete facilities must be rebuilt, as well as expanded, to continue efficient support of both new and old responsibilities. In the third case, a shore station simply outgrows its physical limitations, necessitating permanent relocation to another site. It is the last situation which motivated the analysis for this paper.

With the planned addition of one more fixed-wing aircraft to its allowance, the Coast Guard's Air Station at San

Francisco, California, will no longer be able to house all of its aircraft in available hangar facilities. Although there is physical space to build a new hangar <u>in situ</u>, one key alternative being considered is to relocate at Hamilton Air Force Base, which is approximately 28 miles north of the present station. It is the purpose of this paper to:

(1) Examine the proposed move from an operational standpoint;

(2) Through accepted techniques of quantitative analysis, develop a methodology to determine the effect of the move on operations; and

(3) Provide statistically significant conclusions which can be used by management as an aid in making the decision concerning the move.

There are many important considerations that must be weighed in making a decision of this type. Listed below are some of these factors, along with the key questions which should be answered in order to make a realistic decision:

(1) Cost

(a) What will be the initial capital outlay required to make the move?

(b) What will be the annual operating and maintenance costs required to run the station?

(c) What will be the projected long-term capital outlay required to operate the station?

(2) Facilities

(a) Are the present facilities adequate and suitable for Coast Guard needs?

(b) What facilities at the Base will the Coast Guard desire to control?

(c) Can the desired facilities be acquired from the Air Force?

(d) Will facilities have to be shared with other tenants?

(3) Political/Military

(a) Are there political pressures being exerted to move to Hamilton?

(b) Are there underlying military needs for maintaining Hamilton in the federal inventory for possible future use?

(4) Command Relationships

(a) What type of agreement will the Coast Guard be operating under?

(b) What control will the Coast Guard have over matters affecting its occupancy?

(c) What conditions will require the Coast Guard to vacate Hamilton?

(5) Support

(a) What are the logistic problems associated with Hamilton?

(b) What support facilities, such as family housing, exchange and recreational facilities, should be included?

(c) What will be the impact on the Coast Guard if other tenants withdraw from Hamilton, leaving the Coast Guard as sole occupant?

(6) Operational

(a) What will be the impact on the effectiveness of operations?

(b)What other considerations, such as weather, may affect operations?

(7) Miscellaneous

(a) What will be the effect on personnel caused by the move?

(b) What demographic data is available to provide information concerning the center of gravity of the population and boats in the area and the future location of new marinas?

(c) Will the station adjust its response criteria to the new location, rather than base response on the need of the case?

Some of these considerations are quantifiable, while others are very subjective. Question 6(a), concerning the impact on the effectiveness of operations, will be the only consideration approached herein.

In order to understand the problems involved in making a facility-location decision, an understanding of Coast Guard operations is required. An explanation of the data source available for use in this type of project is also

an important background topic and will subsequently be covered in detail. The following two chapters provide the above indicated information, while, at the same time, making significant progress toward the development of the strategy to be used in the analysis.

II. THE GENERAL BACKGROUND

A. COAST GUARD PROGRAMS

Presently, the Coast Guard has major responsibilities for the following operational programs in the national interest:

(1) Search and Rescue (SAR)

(2) Domestic Icebreaking (DI)

(3) Marine Environmental Protection (MEP)

(4) Enforcement of Laws and Treaties (ELT)

(5) Radionavigation Aids (RA)

(6) Short Range Aids to Navigation (AN)

(7) Marine Science Activities (MSA)

(8) Port Safety and Security (PSS)

(9) Recreational Boating Safety (RBS)

(10) Commercial Vessel Safety (CVS)

(11) Bridge Administration (BA)

(12) Military Operations and Preparedness (MO, MP)

(13) Polar Operations (PO)

(14) Coast Guard Reserve Forces (RT)

Appendix A lists the objectives for the above programs and provides the statutory authority for Coast Guard involvement therein. In addition to these, in-house programs exist to support the operational programs in such areas as communications; engineering (aeronautical, civil, naval, electronics and ocean); personnel; research, development, testing and evaluation; finance; medical; and security.

The best known of these programs is SAR, which has come to be regarded as the traditional mission of the Coast Guard. Of the approximately 1,000,000 operating hours logged by units in the performance of their duties during FY-73, approximately 21% (211,000 hours) was devoted to this single program. The workload associated with SAR missions may be categorized into three basic elements--the transit, the search, and the rescue phases. The important consideration here is that transit time to scene is highly dependent on the responding unit's location, whereas neither the search nor rescue time is dependent on this factor. Thus, regardless of a Coast Guard unit's location, time to search and render assistance will be primarily an uncontrollable function of the individual case variables. Therefore, transit time is the most significant factor of the three basic SAR response elements necessary for direct consideration in a unit location problem.

In further support of the statutory objective of the SAR program, a National Search and Rescue Plan has been implemented to coordinate the effective utilization of all available facilities in all types of search and rescue missions. The Plan delineates three SAR regions--Inland, Maritime and Overseas--and designates the Coast Guard as cognizant agency for the Maritime Region. This responsibility covers a broad expanse of ocean, which on the West Coast includes most of the North Pacific Ocean. For its

own purposes, the Coast Guard has divided its area into three zones:

(1) Long range--the areas beyond 300 miles from the coast;

(2) Medium range--the band between 150 and 300 miles from the coast;

(3) Coastal and Harbor--this zone includes rivers, bays and inlets, and extends 150 miles to seaward.

Analysis by the Coast Guard indicates that a very heavy case load occurs within the Coastal and Harbor Zone. Two important characteristics associated with such cases have been revealed. First, incidents which may be classified as catastrophic in severity occur with the greatest frequency within this zone. Capsizing, burning, grounding, sinking, overdue vessels; personal injuries, illness, and stranding; and ditching of aircraft are examples of such incidents. These emergencies create the need for rapid arrival on scene as well as the requirement for a rescue capability. Secondly, approximately 45% of the SAR cases in the Coastal and Harbor Zone are associated with the recreational boating population [p. I-SAR-9, Ref. 12]. Although this fact also implies increased activities during leisure hours, the more important implication again dictates a rapid response capability, since recreational boats, on the average, are not as well equipped to contend with adversities as are vessels of other uses. As a result of these considerations, several

SAR mission criteria have been established. One of these states that SAR aviation units shall, within the Coastal and Harbor Zone, be capable of flying to the scene of 75% of the assistance cases within one-half hour and 90% within one hour and be capable of recovering (rescuing) persons in distress [p. I-SAR-24, Ref. 12].

Because the SAR mission is primarily concerned with the saving of life and property after a distress situation develops, regardless of the zone in which the case occurs, SAR is strongly time-oriented. "The longer a person or his property is exposed to a hostile environment, the greater are the chances that an occurrence will turn into a disaster, resulting in the loss of life and/or property" [p. I-SAR-5, Ref. 12]. However, for the most part, the other 13 operational programs do not demand as prompt a response. Although timely reaction is essential to the effective conduct of these programs, the result of slower response is not as damaging as with SAR. The consensus of operational commanders on a recent survey was that a rapid response should be provided to support the law enforcement program, to cover actual oil pollution incidents, and to provide emergency aids-to-navigation repair service. It was further agreed that the current SAR criteria were sufficient to provide the rapid response required in the three additional areas outlined above.

B. COAST GUARD RESOURCES

To perform the functions of all operational and support programs, the Coast Guard currently has a personnel strength of approximately 40,000; and an active inventory of 240 cutters, 174 aircraft and 2300 small boats. Since the problem being analyzed herein concerns an air station, only the aircraft resources will be examined in closer detail. There are presently four types of operational aircraft in the Coast Guard inventory:

(1) 21 HC-130--four-engined, fixed-wing, long range search;

(2) 27 HU-16E--twin-engined, fixed-wing, amphibious, medium range search;

(3) 86 HH-52A--single-turbine, amphibious helicopter, short range recovery;

(4) 40 HH-3F--twin-turbine, amphibious helicopter, medium range recovery [p. II-CAP-3, Ref. 12].

Appendix B provides a more complete description of each of these aircraft, including their capabilities and limitations. In general, the HC-130 is utilized in SAR cases which occur in the long range zone or for other missions requiring long range and endurance. Both the HU-16E and HH-3F are employed primarily in missions which involve the medium range zone. The major difference between the two is that the HU-16E is a search aircraft, while the HH-3F is a rescue unit. The workhorse of the Coastal and Harbor

Zone is the HH-52A helicopter, which comprises approximately 50% of the Coast Guard aircraft inventory. However, because of limited navigation capability which permits only line-of-sight distances from the nearest visual or radio-navigation aid, this helicopter requires an escort for any operations over 25 miles offshore.

Nationwide the above aircraft log a total of 63,000 mission flight hours annually, or about six percent of the total hours for all Coast Guard resources [p. I-SUM-6, Ref. 12]. Of this flight time, approximately 45% is in support of the single mission, SAR. The next seven programs, as listed at the beginning of this chapter, utilize another 45%, and the other operational and support programs require the remaining 10% of flight hours. Table I shows the percentages of FY-74 flight time, by aircraft type, devoted to key operational programs. Information to compute these percentages was obtained from Ref. 12 (p. I-SUM-6). Lastly, of statistical interest in this study of resources is the fact that 90% of all cases responded to by Coast Guard aircraft occur in the Coastal and Harbor Zone [p. I-SAR-7, Ref. 12].

C. COAST GUARD AIR STATION SAN FRANCISCO

Coast Guard Air Station San Francisco (AIRSTA SFRAN) was originally established in 1940 at its present location at the San Francisco International Airport (37-37N, 122-23W). Today the command has grown to become a major center of

TABLE I

PERCENTAGES OF FLIGHT HOURS FOR
KEY MISSIONS (NATIONWIDE)

	SAR	MEP	ELT	OTHER
HC-130	40%	9%	27%	24%
HU-16E	24%	40%	19%	17%
HH-3F	60%	21%	3%	16%
HH-52A	52%	27%	1%	20%

Coast Guard resources on the Pacific Coast, with responsibilities in the operational missions of SAR, MEP, ELT, RA, AN and MSA. Both operationally and administratively this unit reports to Commander, Coast Guard District Twelve (CCGDTWELVE) who has control over all Coast Guard resources between the northern California border (42-00N) and the mouth of the Santa Maria River (34-58N). The next link in the operational chain of command is Commander, Pacific Area (COMPACAREA), who oversees all operations in the Pacific, including those of CCGDTWELVE and four other Districts. Actually, COMPACAREA and CCGDTWELVE are vested in the same person, a vice admiral with headquarters in San Francisco.

To perform its many missions, AIRSTA SFRAN has a present allowance of three HC-130's, three HU-16E's and five HH-52A's. Table II shows the percentages of FY-74 SFRAN flight hours, by aircraft type, devoted to key operational programs.

Information to compute these percentages was obtained from Ref. 12 (p. I-SUM-6).

TABLE II

PERCENTAGES OF FLIGHT HOURS FOR KEY MISSIONS (SAN FRANCISCO)

	SAR	MEP	ELT	OTHER
HC-130	53%	13%	21%	13%
HU-16E	32%	37%	13%	18%
HH-52A	57%	21%	0%	22%

Listed below are some of the important relationships between AIRSTA SFRAN's resources and other Coast Guard aircraft:

(1) SFRAN is the only Air Station in CCGDTWELVE;

(2) SFRAN has no HH-3F medium range recovery aircraft;

(3) The only other HC-130's on the Pacific are located in Hawaii and Alaska;

(4) There are no HU-16E aircraft on the Pacific south of San Francisco;

(5) The nearest HU-16E's are located at Port Angeles, Washington;

(6) The nearest Air Station to the south is at Los Angeles, approximately 340 air miles away. AIRSTA

Los Angeles has no other aircraft but the HH-52A helicopter;

(7) The nearest Air Station to the north is at North Bend, Oregon, approximately 425 air miles away. AIRSTA North Bend has no other aircraft but the HH-52A helicopter;

(8) The nearest HH-3F's are located at San Diego to the south and Astoria, Oregon, to the north. These represent air distances of approximately 460 and 755 miles, respectively, from San Francisco.

AIRSTA SFRAN is ready to respond to any mission 24 hours a day. One fixed-wing aircraft and one helicopter, with their crews, are on immediate standby at all times. Although the Air Station represents but one command, the total resources available for dispatch are many. When more than one aircraft from the same Air Station is assigned to a single case, the response is, per se, multi-unit. However, for SAR record purposes, this is not classed as a multi-unit case, but as a single unit, multi-sortie case. Only if another command becomes involved (e.g., Coast Guard Station Monterey) would the case be termed multi-unit, as well as multi-sortie. If the two involved commands are from the same District, it is normal for the District to assume control of the case, which is then classed as a District multi-unit response. If the two commands are from different Districts, then the Area usually assumes control, making an Area multi-unit case.

As previously mentioned, an alternative site for AIRSTA SFRAN is being considered at Hamilton Air Force Base (38-04N, 122-30W). The base is located in Marin County on San Pablo Bay near Novato, California. This places Hamilton approximately 28 miles north of San Francisco International Airport. Currently, Hamilton has Army and Air Force Reserve tenants, with considerable excess space.

From the information provided in this section, there is sufficient justification to assume that SAR is the only mission which would be sufficiently affected by the proposed move from the San Francisco Airport to warrant further study. Because the fixed-wing aircraft primarily operate at distances greater than 150 miles offshore, because their speed is relatively fast, and because the proposed move of San Francisco Air Station is such a short distance, it is furthermore assumed that the impact on these type aircraft will be insignificant. Therefore, this study will concentrate primarily on the impact of the move as it affects the SAR mission of helicopters.

III. THE DATA BASE

A. SAR ASSISTANCE REPORT

Because SAR has been a long-standing mission of the Coast Guard, more background data exists for this area than for any other. Although many reporting systems have evolved through the years to aid both operational and administrative decision makers in conducting the SAR program, it was in 1970 that the present-day version of the report was first utilized. Every time a Coast Guard resource is employed to assist persons or property, an Assistance Report (CG-3272) must be completed. The form contains a considerable amount of information which is codified for easy key-punching and data processing. Appendix C provides a copy of the CG-3272 along with a complete listing of the items and codes to be found on an Assistance Report. As may be noted, many of the items are ordinal (e.g., unit case number, day and time) or cardinal (e.g., wind, sea, distance offshore) in nature, while other categories are simply nominal (e.g., resource, nature of distress and assistance rendered). Also of concern is the fact that several items use a code "9" to mean "unknown" or "other"--a practice which causes some problems for data analysis.

Although most items on the form are self-explanatory, a general overview of the report and a few explicit details are in order. The Assistance Report is divided into three

parts--Identification Data, Case Data and Sortie Data. As the name implies, the first section is used primarily to distinguish each report from all other reports. The Case Data portion provides pertinent data concerning the distressed unit and the case as it exists (e.g., vessel description, environmental conditions and location). Sortie Data then completes the report by summarizing information from the participating Coast Guard resources' standpoint.

In this study, the individual items of Number of Sorties, Distance Offshore, Distance to Scene and the multi-unit case prove very important and need further explanation. A sortie, for aircraft purposes, is terminated when the rotors or propellers are shut down. By way of example, two sorties for a single case could occur as follows:

(1) Two helicopters respond to the same incident, each flying one sortie;

(2) One helicopter, escorted by an HC-130, responds to a case;

(3) One helicopter responds to a case, returns for refueling, and goes out again on the same case;

(4) One helicopter responds to a case, shuts down while offloading an injured person at a local hospital, and then returns to the air station.

Although there are numerous other ways to achieve two sorties, the above examples cover the general type situations that occur on multi-sortie cases. It is not uncommon

to have many sorties (3-10) on any given case. In unusual instances, such as the deployment of a helicopter to a flood area for several days, 10 to 30 sorties could be expected in conducting a single case.

The organization of the present Assistance Report requires that a separate Sortie Data section be completed for each sortie. In the situation where only one command is involved, this will result in one Identification and one Case Data section per case but a varying number of Sortie Data portions. If the assistance is a multi-unit effort, each involved command will submit separate reports which are completed as above. Hence it is possible to have more than one Case Data section for any case. These two inter-related problems of multi-sortie and multi-unit cases will be discussed in a subsequent section. The remaining two report items of Distance Offshore (DISTOFF) and Distance to Scene (DISTSCEN) are often confused and, therefore, need clarification. DISTOFF refers to the distance of a case from the nearest point of land, with no relation to where a Coast Guard unit may be located. On the other hand, DISTSCEN has reference only to the distance of the assigned Coast Guard resource from the position of the distress. If a ready helicopter launches in response to a call, this distance will be measured from the Air Station to the scene. However, if an airborne unit is diverted to respond, the distance to scene will be determined by the location of

the unit at time of diversion. At present there is no way to determine from an assistance report where the unit was at time of assignment to a case.

B. MASTER SAR DATA FILES

At the end of each fiscal year, the data from all Assistance Reports for the entire Coast Guard are key punched and compiled onto a master tape. The resulting logical record is virtually a duplicate of the Assistance Report with one exception. A distinct and complete logical record (consisting of the Identification, Case and one Sortie Data section) is made for each sortie of a multi-sortie case. Hence, there will be as many duplicate Case Data inputs for any given case as there are Sortie Data sections for the original Assistance Report. The same situation would also apply with multi-unit cases. To aid in identification of these cases on the master tape, a record code has been added. This code, placed in each logical record, has the following meanings:

01--A single logical record summarizing the data for an Area multi-unit case (i.e., one which is coded 04).

02--A single logical record summarizing the data for a District multi-unit case (i.e., one which is coded 04).

03--The first sortie record of a case in which all responding resources were from the same command.

04--The first sortie record from a command for a case in which responding resources were from different commands.

10--Any sortie record but the first, from each command in a multi-sortie and/or multi-unit case.

Hence, if one is interested in analyzing data by case, he would be interested in records with codes 1, 2 and 3, while one concerned with sorties would key on codes 3, 4 and 10. In the former situation, the results would include one record (and hence one Case Data section) for each case, while the latter would provide Case Data information weighted by the number of sorties for each case. The method of analyzing the multi-sortie (coded 10) and multi-unit (coded 04) cases in this study is discussed in Chapter V.

The Assistance Report data used in this study was provided by Coast Guard Headquarters in the form of tapes duplicated from the master file for four complete fiscal years (FY-71, FY-72, FY-73, FY-74). In an effort to ensure that the tapes were accurately prepared, a general purpose tape dump program was employed to print out the first logical record from each of the first one hundred blocks on the six tapes. This data was then carefully scanned to confirm that the tapes were being correctly read and that the record format was consistent. No problems of any significance were encountered with any of the tapes.

C. TEMPORARY DATA BASE

Next it was desired to separate out the records required for this study and place them on some storage device that was more convenient and efficient than tapes. It was

determined that three separate data sets would be needed--(1) records for the entire Twelfth Coast Guard District (TWELVDAT); (2) records involving response by CCGDTWELVE aircraft (CCAIRDAT); and (3) records involving response by CCGDTWELVE helicopters (HHSARDAT). Since it might also be necessary to do analysis on each of these data sets by year, the records were sorted in order of ascending years.

At this point, a decision was required to determine just which factors of a response were to be considered in this study, as governed by the record code discussed above. Pending further analysis, it was decided that all applicable records with codes 3, 4 and 10 would be copies from the tapes. This would allow the versatility of performing analyses on either the case or the sortie records simply by keying on the appropriate code.

Based on the projected size of the sets and the availability of equipment, the IBM-2321 data cell was chosen as the storage device. Table III provides a summary of the records found in establishing the three data sets.

The difference between the Total for CCGD12 and the Total for TWELVDAT represents the number of case summary records (coded 1 and 2) for multi-unit cases. Hence, each of the three data sets included all readable records coded 3, 4 or 10.

For the remainder of this paper, codes 3 and 4 will be keyed when results by cases are desired; and codes 3, 4 and 10 will be used when sortie information is desired.

TABLE III

SAR RECORD SUMMARY

	Records Encountered	Total for CCGD12	Total for TWELVDAT	Total for CGAIRDAT	Total for HHSARDAT
FY-71	73,897	5,681	5,658	1,198	819
FY-72	78,318	5,807	5,785	952	633
FY-73	83,265	5,798	5,777	895	626
FY-74	85,565	5,822	5,805	856	557
	321,045	23,108	23,025	3,901	2,635

The author is aware that the case statistics produced for TWELVDAT in this manner will not be absolutely accurate, since data for multi-unit cases will be weighted by the number of commands participating in the case (but not by the number of sorties). This effect will have little consequence on the use of TWELVDAT data due to the infrequency of occurrence of these cases. With San Francisco Air Station being a single command and also being the only air station in CCGD12, codes 3 and 4 will produce complete case data from both CGAIRDAT and HHSARDAT. Although multi-unit cases are included, only one code 4 per case will be found under any one command. Likewise, if two aircraft are sent from the same command, only one resulting record will be a code 3 or 4, since all others are a code 10.

IV. THE GENERAL DATA ANALYSIS

When undertaking any project which involves a large raw data source, it is of basic importance to get a "feel" for what the data means and what, if any, implications are evident. In this way, it is very possible that erroneous assumptions may be disproved, new relationships may be indicated, proposed methodology may be found to be unacceptable, and problems with the data itself may come to light.

A. FREQUENCIES OF CASES

To begin this data analysis a brief examination of each data set in its entirety was made. Table IV provides a breakdown of Table III by record codes. Although the number of cases conducted by aircraft and helicopters both show an approximate 9% annual decline, total cases within CCGD12 have remained relatively stable. To determine whether the frequency of cases has remained uniform over the four-year period, a chi-square test for goodness of fit was performed. This statistic is given by

$$\chi^2 = \sum_{j=1}^{k} \frac{(o_j - e_j)^2}{e_j}$$

where

k = number of data sets being compared

o_j = observed frequency; $j = 1, \ldots, k$

TABLE IV

FREQUENCIES OF RECORD CODES

	TWELVDAT		CGAIRDAT		HHSARDAT	
	3,4	10	3,4	10	3,4	10
FY-71	4,310	1,348	681	517	492	327
FY-72	4,622	1,163	596	356	432	201
FY-73	4,700	1,077	587	308	425	201
FY-74	4,632	1,173	513	343	374	183
Totals	18,264	4,761	2,377	1,524	1,723	912

e_j = expected frequency; $j = 1, \ldots, k$

N = total frequency

$\Sigma o_j = \Sigma e_j = N$

In this instance, it is desired to test if the observed frequencies differ from the empirical distribution $e_j = \frac{N}{k}$. The calculated chi-square values are 19.92, 12.62 and 16.27, respectively. Using a standard chi-square table, the critical value of $\chi_{.95}$ for three degrees of freedom is 7.81. Hence, at a .05 level of significance, the hypothesis that annual case distributions are uniform was rejected. A second item to note is that approximately 20% of the TWELVDAT records are for multiple sorties, while 40% and 35% of CGAIRDAT and HHSARDAT records, respectively, fall into this category. Therefore, a significantly greater percentage of aircraft cases require multi-sorties than do all district cases together. This fact can be explained by such factors as the need to escort HH-52A's offshore, or the difference in definition of an aircraft and vessel sortie.

B. SELECTED CASE VARIABLES

Fourteen key case variables were chosen from the Assistance Report, based primarily on their significant role in any SAR response. These variables include:

(1) Month (MONTH)

(2) Hour (HOUR)

(3) Distance Offshore (DISTOFF)

(4) Severity to Personnel (SEVPER)

(5) Severity to Property (SEVPROP)

(6) Sea State (SEA)

(7) Wind Velocity (WIND)

(8) Visibility (VIS)

(9) Length of Vessel (LENGTH)

(10) Personnel Lost (LOST)

(11) Personnel Saved (SAVED)

(12) Personnel Assisted (ASST)

(13) Type Day (TYPDAY)

(14) Distance to Scene (DISTSCEN)

Since all of the above variables are, by nature, discrete or have been made discrete by the Assistance Report coding process, they lend themselves well to initial examination by histograms. These graphical representations of the frequency distributions were made for the selected items using records with codes 3 and 4 only. This approach was considered appropriate since most other Coast Guard studies also develop SAR statistics around the case, not the sortie. It is of importance here to recall that most of the analysis in this chapter was performed on three different data sets (i.e., TWELVDAT, CGAIRDAT, and HHSARDAT) and that these sets represent varying combinations of Coast Guard resources. The resulting histograms are given in Figures 1 through 14 in Appendix D.

By scaling the frequency of the variables on the ordinate in relative percent, vice the actual frequency,

it is possible to visually discern the change in behavior of the variables between the different resource groups. Although a detailed analysis of this behavior is beyond the scope of this project, one pattern which appears to warrant consideration is readily evident. In both SEVPER and SEVPROP the two end values (0 and 3) increase significantly for both aircraft and helicopter cases, while the corresponding decrease appears primarily in code 1's. In fact, the SEVPER code 2 also shows a marked increase in relative frequency. The increases in the higher severity codes are consistent with what was expected. However, similar increases in the lowest severity code are not readily apparent. If a large number of helicopter or aircraft cases are conducted to rescue swimmers, retrieve stranded persons, and evacuate ill or injured persons, a low danger to property would result. However, no easy explanation can be offered for the similar decrease in danger to personnel.

Using the fourteen variables described above, Table V presents a matrix of arithmetic means for the variables.

C. ANALYSIS OF VARIANCE FOR SELECTED VARIABLES

In order to determine if the means differ significantly among years or between resource groups, the one-way analysis of variance (ANOVA) was chosen as the appropriate method. This test determines whether or not the mean for each of several desired classifications are jointly equal. That is, the test assumes a null hypothesis

TABLE V

MATRIX OF ARITHMETIC MEANS

FOR SAR VARIABLES

	FY-71	FY-72	FY-73	FY-74	TOTAL
MONTH					
TWELVDAT	6.490	6.746	6.708	6.778	6.684
CGAIRDAT	6.078	6.367	6.537	6.579	6.372
HHSARDAT	5.980	6.227	6.412	6.481	6.257
HOUR					
TWELVDAT	13.579	13.725	13.520	13.754	13.645
CGAIRDAT	13.150	13.867	13.424	13.749	13.527
HHSARDAT	13.547	14.259	13.842	14.358	13.974

	FY-71	FY-72	FY-73	FY-74	TOTAL
DISTOFF					
TWELVDAT	1.347	1.299	1.244	1.201	1.271
CGAIRDAT	1.719	1.693	1.539	1.491	1.619
HHSARDAT	1.124	1.106	0.926	1.036	1.051
SEVPER					
TWELVDAT	1.307	1.240	1.333	1.246	1.281
CGAIRDAT	1.649	1.769	2.083	1.907	1.845
HHSARDAT	1.661	1.695	2.111	1.851	1.823
SEVPROP					
TWELVDAT	1.301	1.259	1.299	1.258	1.279
CGAIRDAT	1.262	1.208	1.210	1.233	1.229
HHSARDAT	1.122	1.085	1.125	1.185	1.128

	FY-71	FY-72	FY-73	FY-74	TOTAL
SEA					
TWELVDAT	2.228	2.183	2.203	2.142	2.188
CGAIRDAT	2.319	2.294	2.094	2.252	2.246
HHSARDAT	2.032	2.003	1.866	2.117	2.005
WIND					
TWELVDAT	1.337	1.271	1.382	1.309	1.325
CGAIRDAT	1.558	1.520	1.594	1.544	1.554
HHSARDAT	1.508	1.442	1.521	1.503	1.494
VIS					
TWELVDAT	5.178	5.198	5.255	5.276	5.229
CGAIRDAT	5.584	5.465	5.654	5.707	5.597
HHSARDAT	5.622	5.533	5.746	5.859	5.682
LENGTH					
TWELVDAT	2.463	2.388	2.289	2.329	2.365
CGAIRDAT	1.989	2.074	1.708	1.856	1.911
HHSARDAT	1.746	1.768	1.337	1.682	1.636

	FY-71	FY-72	FY-73	FY-74	TOTAL
LOST					
TWELVDAT	0.031	0.025	0.039	0.030	0.031
CGAIRDAT	0.044	0.039	0.119	0.092	0.072
HHSARDAT	0.055	0.042	0.151	0.107	0.086
SAVED					
TWELVDAT	0.048	0.048	0.064	0.049	0.052
CGAIRDAT	0.059	0.117	0.136	0.121	0.106
HHSARDAT	0.079	0.137	0.158	0.118	0.121
ASST					
TWELVDAT	1.642	1.849	1.871	1.974	1.837
CGAIRDAT	1.263	2.169	0.838	1.335	1.401
HHSARDAT	0.457	0.720	0.605	0.901	0.656

	FY-71	FY-72	FY-73	FY-74	TOTAL
TYPDAY					
TWELVDAT	2.463	2.407	2.331	2.303	2.374
CGAIRDAT	2.677	2.678	2.605	2.801	2.686
HHSARDAT	2.498	2.465	2.468	2.722	2.531
DISTSCEN					
TWELVDAT	1.854	1.826	1.893	1.814	1.847
CGAIRDAT	3.574	3.535	3.925	3.772	3.694
HHSARDAT	2.894	2.843	3.158	3.083	2.987

$$H_0 : \mu_{\cdot 1} = \mu_{\cdot 2} = \mu_{\cdot 3} = \ldots = \mu_{\cdot\cdot}$$

against the alternate hypothesis

$$H_1 : \text{not all column means are equal.}$$

All ANOVA computations were performed with a FORTRAN program written to handle grouped data. A confidence interval of .95 was used to determine the appropriate critical F-statistic. One shortcoming of the ANOVA is that when more than two means are involved, rejection of the null hypothesis does not necessarily offer any insight as to which ones are causing the rejection. To handle this problem, the ANOVA program was also written to perform Scheffé's method of linear contrasts. This test makes pairwise comparisons of all column means, checking the null hypothesis that:

$$H_0 : \mu_{\cdot m} - \mu_{\cdot n} = 0, \; 1 \leq m, n \leq k, \; m \neq n$$

Rejection of this null hypothesis will isolate the pairs of means which are causing rejection of the joint null hypothesis. Results of the linear contrasts corresponding to the appropriate ANOVA's are given in Appendix E.

Utilizing the comparison of the three data sets by years, Table VI presents the ANOVA results based on the use of code 3 and 4 records only (i.e., only the first sortie of multi-sortie cases was considered). The critical F-statistic was 2.60 in all cases.

TABLE VI

ANALYSIS OF VARIANCE RESULTS

COMPARING ANNUAL DATA

	TWELVDAT		CGAIRDAT		HHSARDAT	
	F COMP	(RESULT)	F COMP	(RESULT)	F COMP	(RESULT)
MONTH	8.703	(REJ H_o)	3.273	(REJ H_o)	2.296	(ACC H_o)
HOUR	2.281	(ACC H_o)	2.373	(ACC H_o)	2.626	(REJ H_o)
DISTOFF	17.038	(REJ H_o)	2.431	(ACC H_o)	5.345	(REJ H_o)
SEVPER	12.134	(REJ H_o)	13.572	(REJ H_o)	11.506	(REJ H_o)
SEVPROP	3.126	(REJ H_o)	0.222	(ACC H_o)	0.407	(ACC H_o)
SEA	4.485	(REJ H_o)	2.639	(REJ H_o)	2.557	(ACC H_o)
WIND	13.361	(REJ H_o)	0.530	(ACC H_o)	0.598	(ACC H_o)
VIS	3.454	(REJ H_o)	1.657	(ACC H_o)	2.541	(ACC H_o)
LENGTH	12.901	(REJ H_o)	3.933	(REJ H_o)	6.289	(REJ H_o)
LOST	1.703	(ACC H_o)	2.484	(ACC H_o)	2.283	(ACC H_o)
SAVED	1.959	(ACC H_o)	4.310	(REJ H_o)	2.444	(ACC H_o)
ASST	3.744	(REJ H_o)	1.511	(ACC H_o)	3.464	(REJ H_o)
TYPDAY	5.739	(REJ H_o)	0.859	(ACC H_o)	1.404	(ACC H_o)
DISTSCEN	2.370	(ACC H_o)	5.359	(REJ H_o)	6.599	(REJ H_o)

COMP = COMPUTED   ACC = ACCEPT   REJ = REJECT

From Table VI, it can be seen that 10 out of 14 variables in TWELVDAT differ significantly from year to year. Only HOUR, LOST, SAVED and DISTSCEN are statistically equal over the period being considered. The variables for the remaining two data sets appear to be more consistent, with the null hypothesis being accepted eight out of 14 times for both CGAIRDAT and HHSARDAT. However, in several instances, the same variable is not either totally accepted or rejected across the data sets. DISTSCEN, which is an important consideration in this study, is a good example, being accepted in TWELVDAT and rejected in the other two. Likewise, several reversals of outcome can be noted between CGAIRDAT and HHSARDAT. The above results indicate that while some variables may remain constant from year to year, others differ significantly. Hence, in general, a single year of data was not a good estimator for a future year's results. Therefore, the major portion of this study was based on pooled data for the four years.

It was next desired to determine if the means of the variables for aircraft cases differed from the means for all District cases. The implied test, therefore, was a one-way ANOVA using TWELVDAT and CGAIRDAT. However, since the latter is a subset of the former (i.e., not independent), the ANOVA was run with CGAIRDAT and (TWELVDAT - CGAIRDAT). With only two values being compared in this situation, linear contrasts are meaningless and therefore were not

performed. Similarly, an ANOVA was conducted using HHSARDAT and (TWELVDAT - HHSARDAT). Table VII summarizes these results. The critical F-statistic for this test was 3.841 in all cases.

TABLE VII

ANALYSIS OF VARIANCE RESULTS
COMPARING RESOURCES

	(TWELVDAT - CGAIRDAT) BY CGAIRDAT)		(TWELVDAT - HHSARDAT) BY HHSARDAT	
	F COMP	(RESULT)	F COMP	(RESULT)
MONTH	31.111	(REJ H_o)	40.550	(REJ H_o)
HOUR	1.502	(ACC H_o)	8.011	(REJ H_o)
DISTOFF	312.289	(REJ H_o)	86.617	(REJ H_o)
SEVPER	999.310	(REJ H_o)	630.610	(REJ H_o)
SEVPROP	7.257	(REJ H_o)	46.859	(REJ H_o)
SEA	6.472	(REJ H_o)	46.915	(REJ H_o)
WIND	179.455	(REJ H_o)	69.134	(REJ H_o)
VIS	129.014	(REJ H_o)	137.889	(REJ H_o)
LENGTH	249.520	(REJ H_o)	460.257	(REJ H_o)
LOST	43.747	(REJ H_o)	57.482	(REJ H_o)
SAVED	59.926	(REJ H_o)	65.409	(REJ H_o)
ASST	21.553	(REJ H_o)	110.563	(REJ H_o)
TYPDAY	63.921	(REJ H_o)	11.230	(REJ H_o)
DISTSCEN	4955.984	(REJ H_o)	1096.964	(REJ H_o)

It is readily apparent from above that little similarity exists between the statistics for aircraft or helicopter cases and those for the cases of other CCGDTWELVE resources. Because of this inequality of variable means, the type of cases handled by aircraft was significantly different from those handled by surface vessels.

In a similar manner, the ANOVA was also used to test the null hypothesis that the variable means for the records coded 3 and 4 are the same as the means for the code 10 records in each of CGAIRDAT and HHSARDAT. Table VIII provides the results. The critical F-statistic was 3.841 for all these tests.

TABLE VIII
ANALYSIS OF VARIANCE RESULTS
COMPARING RECORD CODES

	CGAIRDAT (3,4) BY CGAIRDAT (10)		HHSARDAT (3,4) BY HHSARDAT (10)	
	F COMP	(RESULT)	F COMP	(RESULT)
MONTH	4.914	(REJ H_o)	0.573	(ACC H_o)
HOUR	21.533	(REJ H_o)	15.158	(REJ H_o)
DISTOFF	159.888	(REJ H_o)	135.365	(REJ H_o)
SEVPER	184.600	(REJ H_o)	85.768	(REJ H_o)
SEVPROP	144.000	(REJ H_o)	90.274	(REJ H_o)
SEA	191.422	(REJ H_o)	100.662	(REJ H_o)
WIND	121.142	(REJ H_o)	46.833	(REJ H_o)
VIS	61.718	(REJ H_o)	39.646	(REJ H_o)
LENGTH	72.705	(REJ H_o)	26.165	(REJ H_o)
LOST	21.111	(REJ H_o)	20.357	(REJ H_o)
SAVED	0.946	(ACC H_o)	3.808	(ACC H_o)
ASST	0.641	(ACC H_o)	19.260	(REJ H_o)
TYPDAY	8.261	(REJ H_o)	18.035	(REJ H_o)
DISTSCEN	68.383	(REJ H_o)	19.311	(REJ H_o)

If these results had indicated there was no difference in the variable means for each of the two data subsets, then it would make little difference whether further analyses were performed using records with only codes 3 and 4

or codes 3, 4 and 10. The choice of the latter, of course, would offer a larger data set, which would be the preferred alternative.

D. SELECTED VARIABLE STATISTICS FOR CCGDTWELVE

Lastly, a few key variables were examined either in light of the nationwide average for the variable or in light of the importance to the relocation question at hand. For the entire Twelfth District it was determined that 98.8% of all cases responded to occurred within the Coastal and Harbor Zone (i.e., within 150 miles of the coast). Because HC-130 and HU-16E aircraft work long and medium range cases, the similar statistic of 95.6% for CGAIRDAT is not unexpected. The 99.3% for HHSARDAT is likewise predictable, although theoretically the range limit of the HH-52A indicates this figure should be 100%. Conceivably the 11 helicopter cases which are coded "greater than 150 miles offshore" could represent slight extensions of the limit in a serious case, miscoding or possibly cases in which helicopters were dispatched on cutters to perform the rescue. In any event it can be seen that the preponderant caseload within the Coastal and Harbor Zone makes the HH-52A helicopter an important resource in this District. Also of interest is the large percentage of cases that occur within three miles of the coast. These figures are 86.7%, 75.9% and 91.4% for TWELVDAT, CGAIRDAT and HHSARDAT, respectively. The closeness to shore of such a large

number of cases could be very indicative of an increased requirement for a rapid response capability. Similarly, as explained in Chapter II, the percentage of cases caused by recreational boats may also partially determine the response requirement. The Twelfth District percentage for recreational boat cases within the Coastal and Harbor Zone is 62%, which is considerably higher than the national average of 45%. No nationwide statistics are available for comparison with the 42% and 48% figures for CGAIRDAT and HHSARDAT, respectively.

In summary, this chapter has applied some standard analysis techniques to the data base being used in the overall study. These analyses have been conducted in an effort to determine facts which may be of value in either the CCGDTWELVE and/or SFRAN AIRSTA SAR program or the unit relocation problem at hand. Several important results summarized below are important factors in succeeding methodology:

(1) Because the variable means between years were different, four years of pooled information was used as the primary data base;

(2) Because the variable means between records with codes 3 or 4 and records with code 10 differed significantly, additional criteria were developed to determine what combination of records should be used;

(3) Since the behaviors of SEVPER and SEVPROP changed significantly for cases responded to by aircraft,

the two variables were evaluated for possible bearing on the decision to move SFRAN AIRSTA.

V. THE ANALYSIS OF DISTANCE DATA

Having gained insight into the statistical nature of the SAR cases in CCGDTWELVE, appropriate groundwork has been laid to proceed with the evaluation of the station relocation question. Based on the discussions, findings and assumptions made in previous chapters, distance to scene will be used as the primary measure for comparison of effectiveness. Although time to scene is the true critical factor, the same results will evolve, since time to scene has a direct linear relationship with distance to scene.

A. CODED DISTANCE TO SCENE

As previously explained, there are two independent sources of this information in the data being used. The first of these is the report variable, DISTSCEN. If correctly coded, this variable will provide the distance from the distressed vessel to the actual location of the responding resource at the time of assignment to the case. However, there is no way to determine from the data base whether or not a plane was already airborne or away from home base when assigned. The main disadvantage to DISTSCEN is that the actual distances are condensed into a limited number of discrete codes representing increasingly large band widths from the resource's position. While a code 1 means one to three miles to scene, a code 6 could be anything from 100 to 150 miles. Because of accuracy requirements,

this measure was not adequate for the purposes of this study.

B. COMPUTED DISTANCE TO SCENE

The second source of distance to scene provides a more accurate figure, but must be derived indirectly from the SAR data. Given the position of a distressed vessel along with the latitude and longitude of the resource, distance between the two points can be computed according to the following formula:

$$D = n\ (\sec C)$$

where

$n = L_1 - L_2$, the difference of the two latitudes L_1 and L_2; and

$\tan C = \frac{DLo}{m}$, DLo being the difference of the two longitudes Lo_1 and Lo_2, and $m = M_1 - M_2$, representing the difference in meridinal parts for latitudes L_1 and L_2;

$$M_j = 7915.7045 \log \tan (45° + \frac{Lj}{2}) - 23.2689 \sin L_j - 0.0525 \sin^3 L_j - 0.0002 \sin^5 L_j \ldots$$

Since the only readily ascertainable resource location is the fixed position of the air station, this solution likewise does not remedy the problem encountered when aircraft are not at home base upon assignment to a case. In theory, such cases should be eliminated from consideration in that

the distances to scene are not a function of the station location, but of the aircraft location. However, no reasonable method could be determined to identify these instances. Also, the apparent randomness of such occurrences reduces any bias effect on the results. Therefore, the assumption was made that all cases will be responded to by aircraft departing from their home station.

In order to calculate the distances to scene as proposed in the above formulation, a FORTRAN computer program was written. This program provided both distance to scene from SAN FRANCISCO and HAMILTON, as well as the mean and standard deviation for the various data sets tested. The sample standard deviation, S, was calculated from:

$$S = \sqrt{\frac{n \sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i\right)^2}{n(n-1)}}$$

Up to this point, all analysis has been performed on data with virtually no screening for quality and consistency control. For purposes of the general analysis in Chapter V, the control provided for compiling the original master tapes was sufficient. However, in relation to the station relocation question, a more careful investigation of the distance data was required.

C. RESULTS OF DISTANCE COMPUTATIONS

In order to determine the effect of the proposed move on SAR response, the above program to compute distance was exercised on CGAIRDAT for each of three resource types. Table IX depicts the results, giving the mean and standard deviation (in parentheses) for the computed distances. Based on the information in Table IX, Table X summarizes the average distance and time-to-scene changes resulting from a move to Hamilton.

Although it is the differences between SFRAN and HAM that are of primary interest, secondary interest is definitely retained in the case versus sortie question presented in Chapter IV. The large increase in the mean distance between the two data sets appears indicative of a positive correlation between distance to scene and number of sorties.

Concentrating on the case responsed to by helicopters, a more detailed examination of the data was made to determine how true a reflection the above figures are of the actual situation. First, the computed distance values for HHSARDAT were pooled into bands having the same widths as the DISTSCEN codes. Since the DISTSCEN codes only apply to the present location of the AIRSTA, only computed distances from SFRAN were used for this analysis. A chi-square goodness of fit test was then conducted to determine whether the two were from the same distribution. The following values were obtained:

TABLE IX

MEANS AND STANDARD DEVIATIONS FOR COMPUTED DISTANCES IN CGAIRDAT

	CODES 3, 4		CODES 3, 4, 10	
	SFRAN	HAM	SFRAN	HAM
HC-130	311.1(379.3)	320.0(381.1)	404.3(517.9)	413.5(517.5)
HU-16E	151.6(494.5)	161.4(493.8)	247.4(707.8)	255.5(706.3)
HH-52A	35.3(134.3)	40.7(134.1)	49.5(203.8)	55.5(202.7)

TABLE X

SUMMARY OF DISTANCE AND TIME CHANGES FOR MOVE TO HAMILTON

	CODES 3, 4		CODES 3, 4, 10	
	DISTANCE	TIME	DISTANCE	TIME
HC-130	+8.9 mi.	+2 min.	+9.2 mi.	+2 min.
HU-16E	+9.8 mi.	+4 min.	+7.9 mi.	+3 min.
HH-52A	+5.4 mi.	+4 min.	+6.0 mi.	+4 min.

(1) For codes 3 and 4, $\chi^2 = 167.81$

(2) For code 10, $\chi^2 = 116.44$

(3) For codes 3, 4, and 10, $\chi^2 = 268.14$

Using a .05 level of significance, which gives a critical chi-square of 14.067, the null hypothesis is rejected in all three instances. Possible explanations for this discrepancy could be miscoding of DISTSCEN, errors in original transcription of latitude and/or longitude, and a significant number of cases which were responded to by units already airborne. A chi-square test was also conducted to see if the computed distances for code 10's came from the same distribution as the distances for codes 3 and 4. The resulting χ^2 of 978.334 indicates there is a significant difference in the two distributions ($\alpha = .05$, $\chi_c^2 = 14.067$).

Because of the rejection of the null hypothesis that the computed distances to scene and DISTSCEN for HHSARDAT were from the same distribution, a more detailed comparison of the two variables was made. Table XI, which is accompanied by the discussion below, shows a breakdown of the comparisons. A primary concern at this point was that HHSARDAT contained data which would bias the results and possibly cause erroneous conclusions. The difficulty arose in developing an objective criteria to be used to reject unsatisfactory data without injecting a new bias in the process. Although the chi-square tests revealed that almost all values were individually significant in causing rejection, little more could be

TABLE XI

CODED VERSUS COMPUTED DISTANCES
IN HHSARDAT

CODED / COMPUTED	3,4 > 150 mi.	3,4 < 150 mi.	10 > 150 mi.	10 < 150 mi.
> 150 mi.	15	28	71	57
< 150 mi.	4	1676	4	780

ascertained knowing, for example, that seven cases computed at less than one mile to scene while 50 were so coded. However, an upper limit for a realistic distance to scene was determined. Proceeding directly seaward, this distance as previously stated, is restricted by fuel capacity to 150 miles for the HH-52A helicopter. If a case is close inshore yet a considerable distance from the Air Station, an entirely different situation exists. By repeated fueling stops along the coast, an HH-52A could theoretically reach a case scene several thousand miles away. Since a fueling stop away from home base would normally take at least 30 minutes, this factor was considered to override any distance-to-scene differential resulting from the move to Hamilton. Therefore, all cases which would require refueling prior to reaching the scene were eliminated from the data base. Through consultation with several Coast Guard helicopter pilots, the distance figure of 150

miles was adopted. The 3-1/2 hour fuel capacity of the HH-52A gives a theoretical maximum of 315 miles with no allowance for wind, time on scene or return to a safe landing. With consideration for these, 250 miles would probably be the realistic maximum one-way distance likely to be considered, while 150 miles was agreed to be a safe "rule of thumb."

To preserve TWELVDAT for possible further use and to simplify handling of the modified data, a new data set, called HELIDAT, was created. Inclusion of data in HELIDAT was determined solely on the criteria that the computed distance from both SFRAN and HAM was less than 150 miles. DISTSCEN was not used in this process. At the time HELIDAT was created, every rejected record was printed out for examination, which led to no conclusive findings per se. However, several general trends are noteworthy.

(1) Most DISTSCEN codes did not agree with the computed distances, with the code tending to represent a shorter distance than the computed figure;

(2) Fourteen of the 43 records rejected were coded as single sortie cases. Of these only seven would be possible according to the 250-mile maximum one-way distance established herein and the computed distance.

(3) Several specific cases in the 150-250 mile range were confirmed as being correct. These cases, all over 10 sorties each, were in response to "annual" requests for

assistance in flood and ice-storm relief work in northern California;

(4) Based on the computed distance and number of sorties, the cases rejected fit the desired pattern (i.e., multi-sortie, distant cases likely to necessitate refueling prior to arrival on scene). This, coupled with the general disagreement of DISTSCEN with computed distance (possibly indicating erroneous position data) lend sufficient justification for rejecting these records from further consideration.

In creating HELIDAT, a total of 45 cases and 125 sortie records were rejected, leaving 1678 codes 3 and 4, and 778 code 10's. The rejected records represented 3% of the cases, but 15% of the sorties, again indicating the high number of sorties related to more distant cases. Table XII provides a summary of the results found when HELIDAT was established. The 30 sorties rejected for the

TABLE XII

SUMMARY OF RECORDS REJECTED FROM HELIDAT

	CODE 3, 4		CODE 10	
COMPUTED DISTANCE	HAM > 150	HAM < 150	HAM > 150	HAM < 150
SFRAN > 150 miles	42	1	98	30
SFRAN < 150 miles	2	1678	6	778

condition SFRAN > 150, HAM < 150 represent only four separate cases, 20 of the sorties being from a single

case. The six sorties under SFRAN < 150, HAM > 150 also represent four cases. Therefore, SFRAN and HAM are responsible for the sole rejection of approximately the same number of cases.

Having obtained a refined data set for helicopter cases, a chi-square test was again applied in an effort to see if the computed distances for the code 10 records came from the same distribution as the codes 3 and 4. As was the case with HHSARDAT, the hypothesis that they did, in fact, come from the same distribution was rejected for both SFRAN and HAM at the .05 level of significance ($\chi^2_{SFRAN} = 364.678$, $\chi^2_{HAM} = 388.300$, $\chi^2_{CRIT} = 28.869$). Continuing with HELIDAT, the means and standard deviations (in parentheses) of the computed distances from SFRAN and HAM were calculated, obtaining the results in Table XIII. The differences between the SFRAN and HAM distance means

TABLE XIII

MEANS AND STANDARD DEVIATIONS FOR COMPUTED DISTANCES IN HELIDAT

	SFRAN	HAM
CODES 3, 4	24.8(22.818)	30.5(23.708)
CODES 3, 4, 10	27.1(26.192)	34.2(26.901)

above closely approximate the corresponding differences from HHSARDAT, as shown by the HH-52A data in Table IX. Two noticeable differences in the figures for HHSARDAT

and HELIDAT are the decrease in the relative values of the means and a large reduction in the standard deviations. Breaking down HELIDAT into yearly subsets produced the results given in Table XIV for case codes of 3 and 4 only.

TABLE XIV

ANNUAL MEANS AND STANDARD DEVIATIONS FOR COMPUTED DISTANCES IN HELIDAT

	SFRAN	HAM
FY-71	23.9(22.948)	28.1(22.510)
FY-72	24.6(23.123)	30.5(24.659)
FY-73	26.4(22.562)	33.2(24.496)
FY-74	24.5(22.608)	30.6(22.976)

The last area of the distance-to-scene variable developed concerned a possible relationship between the severity codes and distance to scene. As discovered in the analysis from Chapter V, the distributions of both the severity to personnel and to property for HHSARDAT differed significantly from those for TWELVDAT. Helicopter cases exhibited a majority of severity 0 and 3 codes, while District cases as a whole peaked sharply at severity code 1. The intent was to determine if severity, in part, may be determined by the position of distress. If such were the case, a decrease in the distance to scene for high severity cases would be much more important than a similar decrease in distance for low severity cases. In fact, it may well be worth an

increase in distance to the low severity cases to obtain a decrease in distance to the high severity cases. Therefore, a program was written to provide the means and standard deviations for HELIDAT distances ranked by severity codes. Table XV contains the results.

This breakdown of distances was also performed on HELIDAT for each of the four years separately. Table XVI provides the expanded results. Examination of the results from both Tables XV and XVI indicates some consistency between the various patterns for each year. However, the important consideration is the difference between individual pairs of means for SFRAN and HAM. In every instance, the distance from HAM is greater than the distance from SFRAN, but the differences vary considerably from a minimum of 1.7 miles to a maximum of 11.5 miles.

TABLE XV

MEANS AND STANDARD DEVIATIONS FOR COMPUTED
DISTANCES IN HELIDAT BY SEVERITY CODES

	SEVPER		SEVPROP	
	SFRAN	HAM	SFRAN	HAM
0	18.880(14.864)	26.330(17.103)	31.036(27.980)	37.213(27.459)
1	20.321(16.417)	25.757(18.125)	19.687(16.707)	25.572(18.516)
2	24.494(24.817)	30.124(24.620)	21.896(16.642)	27.341(19.576)
3	32.725(27.651)	38.202(28.527)	28.147(25.335)	32.324(26.705)

TABLE XVI

ANNUAL MEANS AND STANDARD DEVIATIONS FOR

COMPUTED DISTANCES IN HELIDAT BY SEVERITY CODES

	SEVPER		SEVPROP	
	SFRAN	HAM	SFRAN	HAM
		FY-71		
0	18.121(12.474)	24.523(12.824)	31.428(31.727)	34.406(27.135)
1	19.842(14.971)	22.159(16.512)	17.903(11.519)	20.220(12.325)
2	27.325(28.309)	30.671(26.034)	22.693(14.006)	27.034(18.333)
3	32.380(29.279)	35.758(27.383)	30.136(28.428)	36.323(29.236)
		FY-72		
0	16.592(11.793)	24.455(12.679)	28.631(25.427)	34.365(25.295)
1	19.481(16.252)	25.616(19.404)	19.315(19.817)	28.064(24.538)
2	28.275(25.965)	31.877(29.897)	26.074(20.957)	27.763(24.776)
3	33.351(29.875)	39.502(31.292)	31.260(30.835)	34.606(31.722)

	SEVPER		SEVPROP	
	SFRAN	HAM	SFRAN	HAM
		FY-73		
0	25.732(21.416)	31.211(25.692)	34.506(26.566)	43.061(29.574)
1	21.510(19.731)	32.937(21.211)	22.129(17.941)	33.600(19.155)
2	18.447(14.291)	26.944(17.102)	16.756(11.191)	26.880(14.613)
3	33.243(26.232)	40.349(28.352)	25.129(22.227)	28.459(22.190)
		FY-74		
0	15.839(11.408)	26.402(16.402)	28.326(28.449)	35.062(26.073)
1	21.077(16.310)	26.070(15.410)	21.234(18.907)	26.814(17.352)
2	19.820(24.993)	30.086(19.253)	21.082(17.254)	27.886(18.002)
3	31.762(26.724)	36.057(27.355)	27.527(21.284)	31.572(25.029)

VI. THE ANALYSIS OF RESULTS

A. STATISTICAL SIGNIFICANCE OF RESULTS

The final effort in this study was devoted to determining which of the above obtained results are statistically significant and likely to have relevance to the decision-making process concerning the move. This portion of the study relied on the student's t test for difference of means between the various sets of distances to scene from SFRAN and HAM. The appropriate formula for the desired t test is:

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{Sp\sqrt{(\frac{1}{N_1} + \frac{1}{N_2})}}$$

with the pooled standard deviations, Sp, being determined by

$$\sqrt{Sp = \frac{(N_1 - 1)s_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2}}$$

This formulation assumes that the population standard deviations, σ_1 and σ_2, are equal but unknown. The following hypotheses were tested:

$H_o : \mu_1 - \mu_2 = 0$

$H_1 : \mu_1 - \mu_2 > 0$ where μ_1 is mean distance to scene from HAM;

where μ_2 is mean distance to scene from SFRAN

A one-tailed test was chosen because the prime concern is that the distance to scene from HAM will be greater than from SFRAN. The t test results corresponding to the pairs of mean distances are presented in Appendix F.

The results of these t tests permit several statistically significant conclusions to be drawn concerning the relocation of AIRSTA SFRAN from San Francisco International Airport to Hamilton Air Force Base. Because the number of sorties conducted for a case do not necessarily indicate the number of transits made from the Air Station to the scene, the important considerations are the case data results, not the sortie data results. Likewise, since variable means were shown to differ significantly from year to year, the tests based on the pooled four-year data provide the most meaningful results. For HC-130 and HU-16E, there is no statistical difference between the means for distance to scene from San Francisco International Airport and Hamilton Air Force Base. The same conclusions also hold true for all HH-52A taken together (HHSARDAT). However, when the data set was refined into HELIDAT by removing all cases which were greater than 150 miles to scene, the distance to scene from Hamilton was greater for all trials--case, sortie, pooled and annual. Recall that cases more than 150 miles away were omitted from HELIDAT because of the strong possibility that refueling was necessary prior to reaching the scene. In such instances, the time delay for refueling outweighs the difference in time to scene attributable to the station

relocation. Based on the pooled case data, all cases (regardless of severity) occurred closer to San Francisco than Hamilton.

B. CONCLUSIONS

Based on the methodology employed and the assumptions made, these results lead to the general conclusion that a move to Hamilton Air Force Base will result in a 23% increase in the distance to the scene of HH-52A cases. Other operational factors that may warrant further study include:

(1) Is the weather significantly different at Hamilton Air Force Base?

(2) Are, in fact, missions other than SAR degraded or improved by the proposed move?

As indicated in the introduction, there are many non-operational considerations which also weigh heavily on the decision process. The results of the analysis presented in this paper provide the decision maker with important quantitative information regarding the impact of the distance-to-scene factor if the air station is relocated at Hamilton.

APPENDIX A

OBJECTIVES AND AUTHORITIES FOR COAST GUARD MISSIONS

Search and Rescue

Objective: To render aid to persons and property in distress on, over and under the high seas and waters under the jurisdiction of the United States.

Authority:

A. 14 USC 2 -- "The Coast Guard...shall develop, establish, maintain, and operate with due regard to the requirements of national defense,...rescue facilities for the promotion of safety on, under, and over the high seas and waters subject to the jurisdiction of the United States..."

B. 14 USC 88 -- "In order to render aid to distressed persons, vessels and aircraft on and under the high seas and on and under the waters over which the United States has jurisdiction, and in order to render aid to persons and property imperiled by flood, the Coast Guard may perform any and all acts necessary to rescue and aid persons and protect and save property."

C. 14 USC 141 -- "The Coast Guard may, when so requested by proper authority, utilize its personnel and facilities to assist any Federal agency, State, Territory, possession or political subdivision thereof, or the District of Columbia, to perform any activity for which such personnel and facilities are especially qualified."

Domestic Icebreaking Program

Objective: To provide icebreaking services to increase availability of the Nation's waterways to maritime transportation by extending the navigation season in icebound regions of the United States, thereby minimizing seasonal effects on commerce, industry, and other modes of transportation; and to assist other agencies in prevention of flooding caused by ice accumulation.

Authority:

A. 14 USC 2 -- "The Coast Guard...shall develop, establish, maintain and operate, with due regard to the requirements of national defense, ice-breaking facilities... for the promotion of safety on, under and over the high seas and waters subject to the jurisdiction of the United States,..."

B. 14 USC 93 -- "For the purpose of executing the duties and functions of the Coast Guard, the Commandant may maintain...icebreaking facilities;..."

C. 14 USC 141

Marine Environmental Protection

Objective: To minimize damage to the marine environment, and to its living marine resources, caused by the intentional or unintentional acts of man; to increase man's awareness and consideration of the environmental impact of his actions; and to improve the quality of the marine environment.

Authority:

A. Refuse Act of 1899 (33 USC 407 et seq.) -- prohibits the throwing, discharge or deposit of any refuse matter of any kind into the navigable waters.

B. Oil Pollution Act of 1961 (33 USC 1001-1015) -- prohibits the discharge of oil from vessels, except under certain emergent conditions, in prohibited zones. The prohibited zone of the U.S. is, generally speaking, a belt around the shoreline out to 50 miles.

C. Federal Water Pollution Control Act, as amended (33 USC 1151 et seq.) -- prohibits certain discharges of oil into or upon the navigable waters of the U.S., adjoining shorelines, or the waters of the contiguous zone.

D. Executive Order 11548 -- implements the FWPCA and assigns to the Coast Guard the general responsibility for preventing oil pollution in the marine environment.

E. National Environmental Policy Act (42 USC 4321 et seq.) -- establishes a national policy aimed at protecting and enhancing the environment.

F. Executive Order 11507 -- requires heads of agencies to ensure that all facilities under their jurisdiction are designed, operated and maintained to meet Federal, State, and local environmental quality standards.

G. Federal Water Pollution Control Act, as amended 1972, the '72 Amendments (PL92-500) to the FWPC Act of 1970 substantially expand the Coast Guard's geographical

responsibilities in pollution control and make the provisions of the '70 Act applicable to other hazardous materials as well as oil.

H. <u>The Marine Protection, Research and Sanctuaries Act of 1972</u> (PL-92-532) regulates ocean dumping and extends Coast Guard duties, responsibility and authority in prevention, enforcement and research in dumping and the effects of dumping.

<u>Enforcement of Laws and Treaties</u>

Objective: To protect and preserve the natural resources and national interests on and under the territorial waters, contiguous fisheries zone, and special interest areas of the high seas by all appropriate means including the enforcement of international agreements and Federal laws except for those related to pollution, traffic control, and port and vessel safety.

Authority:

A. <u>14 USC 2</u> -- "The Coast Guard shall enforce or assist in the enforcement of all applicable Federal laws on and under the high seas and waters subject to the jurisdiction of the United States;"

B. <u>14 USC 89</u>, which states in part:

1. "The Coast Guard may make inquiries, examinations, searches, seizures, and arrests upon the high seas and waters over which the United States has jurisdiction, for the prevention, detection, and suppression of violations of laws of the United States...

2. "The officers of the Coast Guard insofar as they are engaged, pursuant to the authority contained in this section, in enforcing any law of the United States shall:

a. be deemed to be acting as agents of the particular executive department or independent establishment charged with the administration of the particular law; and

b. be subject to all the rules and regulations promulgated by such department or independent establishment with respect to the enforcement of the law.

3. "The provisions of this section are in addition to any powers conferred by law upon such officers, and not in limitation of any powers conferred by law upon such officers, or any other officers of the United States."

C. 14 USC 141, which states:

1. (same as stated previously for 14 USC 141 in this Appendix).

2. "The Coast Guard, with the consent of the head of the agency concerned, may avail itself of such officers and employees, advice, information, and facilities, of any Federal agency, state, territory, possession, or political subdivision thereof, or the District of Columbia as may be helpful in the performance of its duties. In connection with the utilization of personal services of employees of state or local governments, the Coast Guard may make payments for necessary traveling and per diem expenses as prescribed for Federal employees by the standardized Government travel regulations."

Radionavigation Aids

Objective: To facilitate safe and expeditious passage of marine and air traffic and to permit precise position-fixing where other more basic methods cannot be used.

Authority:

A. 14 USC 81 -- "In order to aid navigation and to prevent disasters, collisions, and wrecks of vessels and aircraft, the Coast Guard may establish, maintain and operate:

a. aids to maritime navigation required to serve the needs of the armed forces or of the commerce of the United States;

b. aids to air navigation required to serve the needs of the armed forces of the United States peculiar to warfare and primarily of military concern as determined by the Secretary of Defense or the Secretary of any department within the Department of Defense and as requested by any of those officials; and

c. electronic aids to navigation systems (a) required to serve the needs of the armed forces of the United States peculiar to warfare and primarily of military concern as determined by the Secretary of Defense or any department within the Department of Defense; or (b) required to serve the needs of the maritime commerce of the United States; or (c) required to serve the needs of the air commerce of the United States as requested by the Administrator of the Federal Aviation Agency.

Short Range Aids to Navigation

Objective: To facilitate safe and expeditious passage of marine traffic in coastal areas, inland waterways and harbors through a system of audio/visual and electronic navigational aids.

Authority:

A. 14 USC 2 -- "The Coast Guard shall...develop, establish, maintain, and operate, with due regard to the requirements of national defense, aids to maritime navigation, ice-breaking facilities, and rescue facilities for the promotion of safety on, under, and over the high seas and waters subject to the jurisdiction of the United States;..."

B. 14 USC 81 -- "In order to aid navigation and to prevent disasters, collisions, and wrecks of vessels and aircraft, the Coast Guard may establish, maintain and operate:

a. aids to maritime navigation required to serve the needs of the commerce of the United States;..."

Marine Science Activities

Objective: To conduct oceanographic and meteorological activities in furtherance of Coast Guard programs and in the national interest.

Authority:

A. 14 USC 2 -- "The Coast Guard...shall engage in oceanographic research on the high seas and in waters subject to the jurisdiction of the United States;..."

B. <u>14 USC 92</u> -- "For the purpose of executing the duties and functions of the Coast Guard the Secretary may within the limits of appropriations made therefor:

"...design or cause to be designed, cause to be constructed, accept as gift, or otherwise acquire vessels,..."

C. <u>14 USC 93</u> -- "For the purpose of executing the duties and functions of the Coast Guard the Commandant may:

a. maintain water, land, and air patrols, and ice-breaking facilities;..."

D. <u>14 USC 94</u> -- "The Coast Guard shall conduct such oceanographic research, use such equipment or instruments, and collect and analyze such oceanographic data, in co-operation with other agencies of the Government, or not, as may be in the national interest."

E. <u>46 USC 738</u> -- Under the provisions of this statute the President is authorized to enter into international agreements as to ice patrol and the destruction or removal of derelicts in the North Atlantic Ocean and to include in such agreements a provision for payment to the United States by countries party to such agreement of their proportionate share of the expenses involved.

F. <u>46 USC 738a</u>-- This statute authorizes the carrying out of the provisions of the agreements authorized in 14 USC 738. The statute provides that the Coast Guard shall administer these services and shall publish a report annually of the activities involved in carrying out these services.

Port Safety and Security

Objective: To safeguard the Nation's ports and waterways, port facilities, persons in the proximity thereof, and vessels therein against accidental or intentional destruction, loss, damage or injury and by so doing to improve the utilization of ports and waterways by marine transportation and other connecting modes.

Authority:

A. Ports and Waterways Safety Act of 1972 -- The Coast Guard is assigned the responsibility to establish, operate and maintain vessel traffic services and systems for ports, harbors and other water subject to congested traffic and to require vessels to comply with those systems, and to conduct port safety inspections.

B. Magnuson Act of 1950 (64 Stat. 427) -- Authorizes the President to issue rules and regulations to govern the anchorage and movement of foreign flag vessels in the territorial waters of the U.S. when the national security is endangered.

C. Executive Order 10173 -- implemented the Magnuson Act in 1950 and assigned to the Coast Guard the primary responsibility for enforcing the Act. This Executive Order has since been amended by Executive Orders 10277, 10352 and 11249.

Recreational Boating Safety

Objective: To minimize, through preventive measures, the risk of loss of life, personal injury and property

damage associated with the use of recreational boats, thereby providing the boatman maximum safe use of the Nation's waterways.

Authority:

A. Federal Boat Safety Act of 1971: (PL 92-75) This act repeals the Federal Boating Act of 1958 and amends previous legislation; provides for boat and associated equipment safety standards, authorizes regulations governing use of associated equipment, grants in aid to State and local jurisdictions for boat safety activities, a Boating Safety Advisory Council, Federal preemption of safety standards; and extends regulation to all undocumented vessels equipped with propulsion machinery on waters under Federal jurisdiction.

B. Motorboat Act of 1940 (46 USC 526): The law classifies motor vessels by size and specifies safety equipment and procedures for each class; it empowers the Commandant to establish all necessary regulations required to carry out its provisions.

C. Regulation of Marine Parades and Regattas (46 USC 454): This statute empowers the Coast Guard to issue regulations to promote the safety of life on navigable waters during regattas and marine parades.

D. Coast Guard Auxiliary (14 USC 821): Established in 1941 to assist the Coast Guard to:

a. Promote safety and effect rescues.

b. Promote efficiency in operating motorboats and yachts.

c. Foster wider knowledge of, and better compliance with, the laws; rules and regulations governing the operation of motorboats and yachts.

d. Facilitate other operations of the Coast Guard.

<u>Commercial Vessel Safety</u>

Objective: To minimize, through preventive measures, the risk of loss of life, personal injury, and property loss or damage associated with vessels or other facilities engaged in commercial, scientific or exploratory activity in the marine environment.

Authority:

A. <u>General Statutory Authority</u>

1. <u>Reorganization Plan No. 3 of July 16, 1946</u>

By this plan, functions previously vested by law in the Department of Commerce, Bureau of Marine Inspection and Navigation, were transferred to the Commandant, U.S. Coast Guard, and to the Commissioner of Customs. By Reorganization Plan No. 26 of 1950 they were transferred to the Treasury, who, by Treasury Department Order No. 120, delegated authority for performing these functions back to the Commandant and the Commissioner.

B. <u>Coast Guard Statutory Authority</u>

1. <u>14 USC 2</u> -- "The Coast Guard...shall administer laws and promulgate ane enforce regulations for the promotion of safety of life and property on the high seas and on waters subject to the jurisdiction of the United States covering

all matters not specifically delegated by law to some other executive department;..."

2. 46 USC 2 -- "The Commandant of the Coast Guard and the Commissioner of Customs shall have general superintendence of the commercial marine and merchant seamen of the United States, so far as vessels and seamen are not, under existing laws, subject to the supervision of any other officer of the Government. The Commissioner of Customs shall be specially charged with the decision of all questions relating to the issue of registers, enrollments, and licenses of vessels, and to the filing and preserving of these documents; and wherever in this title any of the above-named documents are required to be surrendered and returned to the Commissioner of Customs."

3. 46 USC 3 -- Duties here assigned to Commissioner of Customs, except collection and refund of tonnage tax, now responsibility of Coast Guard (i.e., admeasurement, signal letters, official numbers). "The Commissioner of Customs shall annually prepare and publish a list of vessels of the United States belonging to the commercial marine, specifying... He shall also report annually to the Secretary of the Treasury the increase of vessels of the United States... The Commandant of the Coast Guard and the Commissioner of Customs shall also investigate the operations of the laws relative to navigation, and annually report to the Secretary of the Treasury

such particulars as may, in their individual judgment, admit of improvement or may require amendment."

4. 46 USC 7-8 -- These two sections provide the Commandant or the Commissioner of Customs wide authority concerning remission or mitigation of penalties under laws relating to vessels; authority to ascertain the facts and remit informer's rights; and authority to refund penalties under laws relating to vessels or seamen.

5. 46 USC 362 -- Established certain standards for passenger vessels and required disclosure of construction details on passenger vessels.

6. 46 USC 416 -- "The Commandant of the Coast Guard shall make such regulations as may be necessary to secure the proper execution and carry out the purpose of title 52 of the revised Statutes and sections 369 and 3821 of this title."

7. P.L. 91-224 -- Concerns a broad area of pollution control (oil as well as hazardous polluting substances). While certain responsibilities (e.g., sewage from vessels) have been assigned to the Coast Guard, the full impact of this legislation on Coast Guard programs has yet to be determined.

8. Occupational Safety and Health Act of 1970 (P.L. 91-596) -- An act to assure safe and healthful working conditions for working men and women; ... Under this act, the Coast Guard's comprehensive responsibility for safety on board ships, waterfront facilities, and artificial

islands, and on fixed structures on the outer continental shelf will be affected by the jurisdiction of the Department of Labor over general occupational safety and health conditions.

9. P.L. 92-340 (Ports and Waterways Safety Act) -- Amends the Tank Vessel Act to include environmental considerations.

Bridge Administration

Military Operations and Preparedness

Objective: To perform effectively and with expertise military duties as a specialized service of the Navy in time of war and as otherwise required in the national interest in peacetime. With regard to the Military Preparedness Program, the objective is to maintain an effective, ready, armed force prepared for and immediately responsible to specific tasks in time of peace, war, or national emergency.

Authority:

A. 14 USC 3 -- Coast Guard forces shall be assigned to Naval operations "upon the declaration of war or when the President directs..."

B. 14 USC 141 -- "The Coast Guard may, when requested by proper authority, utilize its personnel and facilities to assist any federal agency...to perform any activity for which such personnel and facilities are especially qualified."

C. 14 USC 145 -- permits the interchange of vessels, equipment, and personnel between the Coast Guard and the Navy "to accomplish such assignments and functions for each other as they may agree are necessary and advisable."

Polar Operations

Objective: To provide icebreaking services to make possible the traverse of polar regions by United States shipping and by so doing to facilitate support of activities of National interest in the polar areas and to enhance the understanding of these regions through the collection of scientific data.

Authority:

A. 14 USC 2 -- "The Coast Guard...shall develop, establish, maintain and operate, with due regard to the requirements of national defense,...icebreaking facilites,... for the promotion of safety on, under, and over the high seas and waters subject to the jurisdiction of the United States..."

B. 14 USC 93 -- "For the purpose of executing the duties and functions of the Coast Guard, the Commandant may maintain...icebreaking facilities;..."

C. 14 USC 94 -- "The Coast Guard shall conduct such oceanographic research, use such equipment or instruments, and collect and analyze such oceanographic data, in cooperation with other agencies of the Government, or not, as may be in the national interest."

D. 14 USC 141 (a) -- "The Coast Guard may, when so requested by proper authority, utilize its personnel and facilities to assist any Federal agency, state, territory, possession, or political subdivision thereof, or the District of Columbia, to perform any activity for which such personnel and facilities are especially qualified."

Coast Guard Reserve Forces

Objective: To recruit, train and maintain a force of officers and men of the numerical strength, rank and rate distribution and skill level necessary to: (1) meet early post M-day and general mobilization requirements, and (2) augment the active duty Coast Guard in the performance of its peacetime missions during domestic emergencies and periods of peak operations.

Authority:

A. PL8-77-Chapter 8-Title 11

"Sec 201. There is hereby created and established a United States Coast Guard Reserve..."

B. 10 USC 262 -- "The purpose of the Reserve Components is to provide trained units and qualified persons available for active duty in the armed forces, in time of war or national emergency and at such other times as the national security requires, to fill the needs of the armed forces whenever, during and after the period needed to procure and train additional units and qualified persons to achieve the planned mobilization, more units and persons are needed than are in the regular components."

APPENDIX B

DESCRIPTION OF AIRCRAFT CAPABILITIES

HC-130

The HC-130 "Lockheed Hercules" is an all weather, high performance four engine, turbo-prop, long range aircraft. As a search aircraft, the "B" model can proceed 1200 nautical miles at 25,000 to 30,000 feet at 300 knots, let down to search altitude, search for 2.5 hours at optimum search speed with two engines shut down, restart the idle engines, and return to base with reserve fuel. The "E" and "H" model C-130's have additional fuel capacity in pylon tanks which increase their range/endurance approximately 30%. The HC-130 is an extremely versatile aircraft, capable of transportation up to 92 passengers, 35,000 pounds of cargo, or large quantities of rescue-survival and oil pollution control equipment either for aerial delivery or transportation to the scene of disasters. It was also designed to operate into short, unprepared air fields.

HU-16E

The HU-16E "Grumman Albatross" is an all weather, amphibious, twin reciprocating engine, medium range aircraft. As a search aircraft, it can proceed 500 nautical miles, search for two and one half hours and return to home base with reserve fuel. Cargo and passenger capacity is limited, but it does provide aerial delivery capability for dewatering pumps, rafts, other rescue-survival equipment.

HH-3F

The HH-3F "Sikorsky Pelican" is an amphibious, twin-turbine, medium range helicopter built by Sikorsky. As a search and rescue aircraft, it can proceed approximately 300 nautical miles at 125 knots, hover for 20 minutes or land on the water, pick up eight survivors, and return to base with reserve fuel. Alternatively, the HH-3F can proceed approximately 200 miles from base, search for two and one-half hours and return to base with reserve fuel.

HH-52A

The HH-52A "Sikorsky Sea-Guard" is an amphibious, single turbine, short range helicopter. As a search and rescue aircraft, it can, with escort, proceed 150 nautical miles offshore at 90 knots, hover for 20 minutes or land on the water, pick up four survivors, and return to base with reserve fuel.

APPENDIX C

EXPLANATION OF CODES FOR ASSISTANCE REPORTS

This appendix contains a copy of the Assistance Report (CG-3272). Following the form is a detailed explanation of the codes to be entered on the report. A CG-3272 is completed every time a Coast Guard resource is deployed to provide assistance to personnel or property in distress.

TYPEWRITER ALIGNMENT | RCS OSR-2000 | PAGE ___ OF ___

DEPARTMENT OF TRANSPORTATION
U. S. COAST GUARD
CG-3272 (Rev. 3-69)

ASSISTANCE REPORT

REPORTING UNIT

NAME OF DISTRESSED UNIT

UNIT CASE OF

A. IDENTIFICATION DATA

01	02	OPFAC
02	09	Multi-Unit Case Number
03	13	Unit Case Number
04	17	Month and Year Notified
05	20	Total Number of Sorties on Case

OWNER (Name, address, zip code)

B. CASE DATA

01	22	Date/Time Notified
02	28	• Time From Occurrence to Notification
03	30	Means of Initial CG Notification
04	32	Nature of Distress
05	34	Distance Offshore
06	35	N Latitude
07	39	W Longitude
08	44	Method of Locating Distress
09	45	Severity — Personnel
10	46	Severity — Property
11	47	Cause of Distress
12	48	Sea State
13	49	Wind
14	50	Visibility
15	51	Type (DESCRIPTION OF DISTRESSED UNIT OR UNIT ASSOCIATED WITH PERSONNEL IN DISTRESS)
16	52	Owner
17	53	Usage
18	55	Propulsion
19	57	Length
20	58	Gross Tonnage
21	59	Off/Reg No.
22	68	Number of Lives Lost
23	70	Number of Lives Saved
24	72	No. of Persons Otherwise Assisted
25	75	0 0 . 0 0 VAL. PPTY Assisted

NATURE OF DISTRESS		
SEVERITY	PERSONNEL	
	PROPERTY	

EXPLAIN "OTHER" CODES; ADD ANY CLARIFYING INFORMATION; STATE ANY UNUSUAL OCCURRENCES.

C. SORTIE DATA

01	20	Type of Assisting Resource
02	22	Assisting Resource No.
03	28	Date/Time Underway
04	34	Number of Resources Remaining on Stand-by
05	35	Date/Time on Scene
06	41	Distance to Scene or Search Area
07	42	• Total Time on Sortie
08	45	Assistance Rendered to Personnel
09	47	Assistance Rendered to Property
10	49	Performance Index — Use Comments

C. SORTIE DATA

01	20	Type of Assisting Resource
02	22	Assisting Resource No.
03	28	Date/Time Underway
04	34	Number of Resources Remaining on Stand by
05	35	Date/Time on Scene
06	41	Distance to Scene or Search Area
07	42	• Total Time on Sortie
08	45	Assistance Rendered to Personnel
09	47	Assistance Rendered to Property
10	49	Performance Index — Use Comments

COMMAND LEVEL	INITIALS	SIGNATURE	DATE
UNIT			
GROUP			
DISTRICT			

• THIS DIGIT REPRESENTS TENTHS OF HOURS

PREVIOUS EDITIONS ARE OBSOLETE

WHITE – COMMANDANT (OSR)

A. IDENTIFICATION DATA

A01 - OPFAC
A six-digit unit identifier unique to each command.

A02 - MULTI-UNIT CASE NUMBER
A four-digit serial number assigned to identify multi-command cases.

A03 - UNIT CASE NUMBER
A four-digit serial number assigned to sequence a command's cases.

A04 - MONTH AND YEAR NOTIFIED
The two-digit month and one-digit year in which the case came to the Coast Guard's attention.

A05 - TOTAL NUMBER OF SORTIES
A two-digit number for the number of sorties conducted by the reporting command.

B. CASE DATA

B01 - DATE/TIME NOTIFIED
A six-digit number indicating the date, hour and minute the case came to the Coast Guard's attention.

B02 - TIME FROM OCCURRENCE TO NOTIFICATION
0.0 - No time elapsed
0.1 - Through 8.9 - Actual time in tenths of hours
9.0 - Nine or more hours
9.9 - Unknown

B03 - MEANS OF INITIAL COAST GUARD NOTIFICATION
00 - Other
01 - Unknown, initial notice given to other CG unit
02 - Telephone or telegraph
03 - Sighted by CG
04 - 2182 kHz
05 - 500 kHz
06 - MF/HF voice (other than 2182)
07 - 156.8 MHz
08 - VHF/FM voice (other than 156.8)
09 - District working frequency
11 - Personally informed
12 - 121.5 MHz
13 - 243 MHz
14 - AMVER calling bands
15 - Marine Operator
16 - Citizen's Band (25-28 MHz)
17 - Amateur Radio
18 - Relayed by Commercial Radio Station
19 - Emergency position indicating radio beacon (Specify frequency in COMMENTS SECTION)

B04 - NATURE OF DISTRESS (VESSEL CONDITIONS)

00 - Other
01 - Disabled, adrift
02 - Disabled, anchored
03 - Aground
04 - Capsized
05 - Fire/Explosion
06 - Flooding/Sinking
07 - Overdue/Missing
08 - Collision
09 - Unfamiliar with area/disoriented
11 - Endangered by weather
12 - Endangered by ice

(AIRCRAFT CONDITIONS)

20 - Other aircraft conditions
21 - Ditch/Forced landing
22 - Crash
23 - Low on fuel
24 - Bail out
25 - Fire Explosion
27 - Overdue/Missing
28 - Mechanical casualty
29 - Unfamiliar with area/disoriented

(LAND VEHICLE CONDITIONS)

40 - Other land vehicle conditions
42 - Crash (or accident)
43 - Overdue/Missing

(LAND OR OFFSHORE STRUCTURE CONDITIONS)

50 - Other, etc.
51 - Flooding
55 - Fire/Explosion
57 - Missing

(DIVER CONDITIONS)

70 - Other diver conditions
71 - Stranded
72 - Personnel in water
73 - Bends
74 - Air Embolism
75 - Emphysema
76 - Equipment failure
77 - Overdue/Missing
78 - Predator attack

(PERSONNEL, OTHER THAN DIVER, CONDITIONS)

80 - Other personnel conditions
81 - Drowning
82 - Personnel in water
84 - Sickness
85 - Injury
87 - Missing

(MISCELLANEOUS CONDITIONS)
90 - Other conditions
98 - Flare sighting
99 - Unknown

B05 - DISTANCE OFFSHORE
0 - Land
1 - 0-3 miles
2 - 3.1-10 miles
3 - 10.1-25 miles
4 - 25.1-50 miles
5 - 50.1-100 miles
6 - 100.1-150 miles
7 - 150.1-300 miles
8 - Greater than 300 miles
9 - Unknown

B06 - LATITUDE
The two-digit degree and two-digit minute latitude of the distress

B07 - LONGITUDE
The three-digit degree and two-digit minute longitude of the distress

B08 - METHOD OF LOCATING DISTRESSED UNIT
0 - Other method
1 - Exact position known, no location problem
2 - Visual sighting only
3 - RDF on Emergency Radio Beacon
4 - Located through communications check conducted by a reporting unit
5 - RDF on Datum Marker beacon
6 - RDF on radio transmissions of distressed unit
7 - Radar
8 - Located by other unit
9 - Not located at termination of case/Unknown

B09 - SEVERITY OF DISTRESS PERSONNEL
0 - None - No personnel were involved
1 - Small - No immediate or foreseeable danger to personnel
2 - Moderate - Some danger that personnel might be lost
3 - Severe - Personnel were in danger of loss or were lost
9 - Unknown

B10 - SEVERITY OF DISTRESS PROPERTY
0 - None - No property was involved
1 - Small - No immediate or foreseeable danger to property
2 - Moderate - Some danger that property might be lost

SEVERITY OF DISTRESS PROPERTY (Continued)

3 - Severe - Property was in danger of loss or was lost
9 - Unknown

B11 - CAUSE OF DISTRESS
0 - Other
1 - Hull failure
2 - Machinery failure
3 - Equipment failure
4 - Personnel factor
5 - Fuel exhausted
6 - Weather
8 - False alarm
9 - Unknown

B12 - SEA STATE
0 - Calm
1 - 1-2 ft.
2 - 3-4 ft.
3 - 5-6 ft.
4 - 7-10 ft.
5 - 11-20 ft.
6 - Greater than 20 ft.
8 - Land
9 - Unknown

B13 - WIND
0 - Calm
1 - 0.1-10 knots
2 - 10.1-20 knots
3 - 20.1-30 knots
4 - 30.1-40 knots
5 - 40.1-50 knots
6 - 50.1-60 knots
7 - 60.1-70 knots
8 - Over 70 knots
9 - Unknown

B14 - VISIBILITY
0 - 0-1/4 mile
1 - Greater than 1/4 - 1/2 mile
2 - Greater than 1/2 - 1 mile
3 - 1.1-3 miles
4 - 3.1-5 miles
5 - 5.1-10 miles
6 - 10.1-15 miles
7 - 15.1-20 miles
8 - Unlimited
9 - Unknown

B15 - TYPE OF DISTRESSED UNIT
- 0 - Other
- 1 - Surface vessel
- 2 - Aircraft/spacecraft
- 3 - Submersible vessel
- 4 - Land vehicle
- 5 - Land structure
- 6 - Offshore structure
- 7 - Hydrofoil or Ground Effects Machine
- 8 - Personnel only
- 9 - Unknown

B16 - OWNERSHIP OF DISTRESSED UNIT
- 0 - Other (includes personnel only)
- 1 - U.S. Corporation or other business association
- 2 - U.S. private individual or individuals
- 3 - U.S. government, other than military
- 4 - U.S. Military
- 5 - Foreign - Corporation or other business association
- 6 - Foreign - Private individual or individuals
- 7 - Foreign - Government, other than military
- 8 - Foreign - Military
- 9 - Unknown

B17 - USAGE OF DISTRESSED UNIT

(VESSELS)
- 00 - Other vessel activity
- 01 - Passenger (for hire)
- 02 - Dry cargo freight
- 03 - Liquid bulk carrier
- 04 - Commercial fishing
- 05 - Cannery/Factory vessel
- 06 - Towing vessel
- 07 - Recreational vessel
- 08 - Oceanographic vessel
- 09 - Man-of-war
- 11 - Charter fishing

(AIRCRAFT)
- 20 - Other aircraft activity
- 21 - Passenger
- 22 - Dry cargo freight
- 23 - Liquid bulk carrier
- 27 - Recreational/Private
- 29 - Man-of-war

(LAND VEHICLE)
- 40 - Other land vehicle
- 41 - Passenger (for hire)
- 42 - Dry cargo freight
- 43 - Liquid bulk carrier
- 47 - Passenger/Private/Recreational
- 48 - Man-of-war

USAGE OF DISTRESSED UNIT (Continued)

(LAND STRUCTURE)
50 - Other land structure activity
52 - Warehouse
55 - Pier
57 - Private domicile
59 - Military structure

(OFFSHORE STRUCTURE)
60 - Other offshore structure activity
61 - Oceanographic
64 - Drill rig

(MISCELLANEOUS CODES)
90 - Other miscellaneous activity
98 - Personnel only
99 - Unknown

B18 - PROPULSION OF DISTRESSED UNIT
(VESSEL)
00 - Non-self propelled
01 - Manually propelled
02 - Inboard
03 - Outboard
04 - Inboard/Outboard
05 - Sail
06 - Sail with inboard
07 - Sail with outboard
09 - Other propulsion

(AIRCRAFT)
20 - Non-self propelled
21 - Rotary-single engine
22 - Rotary-multi engine
23 - Fixed-propeller-single engine
24 - Fixed-propeller-multi engine
25 - Fixed-jet-single engine
26 - Fixed-jet-multi engine
27 - Rocket-powered
29 - Other propulsion

40 - Land vehicle
90 - Not propelled (personnel only and not structures)
99 - Unknown

B19 - LENGTH OF DISTRESSED UNIT
(Applies only to vessels)
0 - Other than vessel
1 - Less than 16 ft.
2 - 16 ft. less than 26 ft.
3 - 26 ft. less than 40 ft.
4 - 40 ft.-65 ft.

LENGTH OF DISTRESSED UNIT (Continued)

5 - Greater than 65 ft.-100 ft.
6 - Greater than 100 ft.-200 ft.
7 - Greater than 200 ft.-300 ft.
8 - Greater than 300 ft.
9 - Unknown

B20 - TONNAGE OF DISTRESSED UNIT
(Applies only to vessels)
0 - Other than vessel
1 - Vessel 65 ft. and less
2 - Less than 10 tons
3 - 10 tons to 50 tons
4 - Greater than 50 tons to 100 tons
5 - Greater than 100 tons to 300 tons
6 - Greater than 300 tons to 1000 tons
7 - Greater than 1000 tons to 10,000 tons
8 - Greater than 10,000 tons
9 - Unknown

B21 - OFF/REG. NO.
A nine-digit space for the appropriate state or federal registration number for the vessel involved.

B22 - NUMBER OF LIVES LOST
A two-digit space for the actual number of lives lost.

B23 - NUMBER OF LIVES SAVED
A two-digit space for the actual number of lives saved.

B24 - NUMBER OF PERSONS OTHERWISE ASSISTED
A three-digit space for the actual number of persons assisted, but not actually saved.

B25 - VAL-PPTY ASSISTED
An eight-digit space for the actual dollar value of property assisted.

C. SORTIE DATA

C01 - RESOURCE TYPE
00 - Land vehicle
11 - Amphibious vehicle (includes Large Cutters)
20 - Other cutter
21 - WHEC
22 - WAGB
23 - WMEC
24 - WPB
25 - WLB,WLM
26 - WLI, WLIC, WLR
27 - WYTM, WYTL

(AIRCRAFT)
30 - Other aircraft
31 - HC-130
32 - HU-16E
33 - HH-52A
34 - HH-3F

(BOATS)
40 - Other non-ship's boats
41 - UT (large) 40 ft.
42 - UT (medium) 30 ft.
43 - UT (light) IB/OB launches (Non-ship)
44 - MLB 44 ft.
45 - MLB 52 ft.
46 - MLB 36 ft.
47 - MRB (include MSB at shore unit)
48 - TICWAN
49 - Buoy boat
50 - Flood relief punt
51 - Skiffs
52 - Ship's boats
70 - Personnel only
80 - Communications Facility only
90 - Auxiliary

C02 - ASSISTING RESOURCE NUMBER
A six-digit space for the boat, hull or aircraft number of the assisting resource.

C03 - DATE/TIME UNDERWAY
The six-digit number indicating the date, hour and minute the assisting resource gets underway.

C04 - NUMBER OF RESOURCES REMAINING ON STANDBY
A one-digit number indicating the number of resources at a command remaining available for dispatch if required.

C05 - DATE/TIME ON SCENE
The six-digit number indicating the date, hour and minute the assisting resource arrived at the reported position of distress.

C06 - DISTANCE TO SCENE OR SEARCH AREA
0 - 0-1 mile
1 - 1.1-3 miles
2 - 3.1-10 miles
3 - 10.1-25 miles
4 - 25.1-50 miles
5 - 50.1-100 miles
6 - 100.1-150 miles
7 - 150.1-300 miles
8 - 300.1-500 miles
9 - Greater than 500 miles

C07 - TOTAL TIME ON SORTIE
The three-digit space for the total hours and tenths of hours spent by the resource on the sortie.

C08 - ASSISTANCE RENDERED PERSONNEL
00 - No assistance rendered to personnel
01 - Searched/Failed to locate
02 - Searched/Located only
03 - Searched/Rescued
04 - Delivered equipment
05 - Vectored other unit to scene
06 - Provided communication facilities
07 - Evacuation (non-medical)
11 - MEDVAC
12 - Provided doctor and MEDVAC
13 - Provided doctor
14 - Radioed medical advice
15 - Delivered medical supplies
16 - Rendered first aid only
17 - Provided safe conduct
18 - MEDVAC requiring recompression
50 - Sortie terminated for logistics
90 - Sortie aborted
98 - Assisted property with personnel aboard
99 - Other

C09 - ASSISTANCE RENDERED PROPERTY
00 - No assistance rendered to property
01 - Searched/Failed to locate
02 - Searched/Located only
03 - Attempted salvage failed
04 - Recovered property
05 - Vectored other unit to scene
06 - Provided communications facilities
07 - Broke ice
08 - Refueled/Resupplied
09 - Gave navigational assistance
11 - Fought fire
12 - Dewatered
13 - Refloated
14 - Delivered pump and equipment
15 - Made repairs
16 - Stood-by
20 - Towed (only assistance rendered)
21 - Fought fire and towed
22 - Dewatered and towed
23 - Refloated and towed
24 - Delivered pump/equipment and towed
25 - Made repairs and towed
26 - Stood-by and towed
27 - Relieved tow
30 - Provided escort (only assistance rendered)

ASSISTANCE RENDERED PROPERTY (Continued)

32 - Dewatered and escorted
33 - Refloated and escorted
36 - Stood-by and escorted
50 - Sortie terminated for logistics
90 - Sortie aborted
98 - Assisted personnel on "property not in danger"
99 - Other

C10 - PERFORMANCE INDEX
0 - Resources functioned adequately
1 - SAR resource was inadequate
2 - Hull failure
3 - Engine failure
4 - Communication failure
5 - Other electronics failure
6 - Pump failure
7 - Other equipment failure
8 - Personnel failure
9 - Other failure

APPENDIX D

HISTOGRAMS OF SELECTED VARIABLES FOR TWELVDAT, CGAIRDAT AND HHSARDAT

This appendix containes Figures 1 through 14, which represent histograms of the fourteen selected variables listed in Chapter IV. These graphical representations of the frequency distributions were made on a case basis for each of the three data sets--TWELVDAT, CGAIRDAT and HHSARDAT. These sets represent varying combinations of Coast Guard resources in the Twelfth District. By scaling the frequency of the variable on the ordinate in relative percent, vice the actual frequency, it is possible to combine the three histograms for each variable on the same page. This allows for easy visual comparison of the results to detect changes in behavior of the variables between the different resource groups. The meanings of the codes on the abscissa can be obtained from Appendix C. One exception to this is that for SEA, code 8, which indicates "land," has been moved up to code 0; and all other definitions have been moved down one code. On all histograms an asterisk (*) indicates a value that is too small to depict because of the scaling factor. A zero (0) indicates no cases had the particular code so marked.

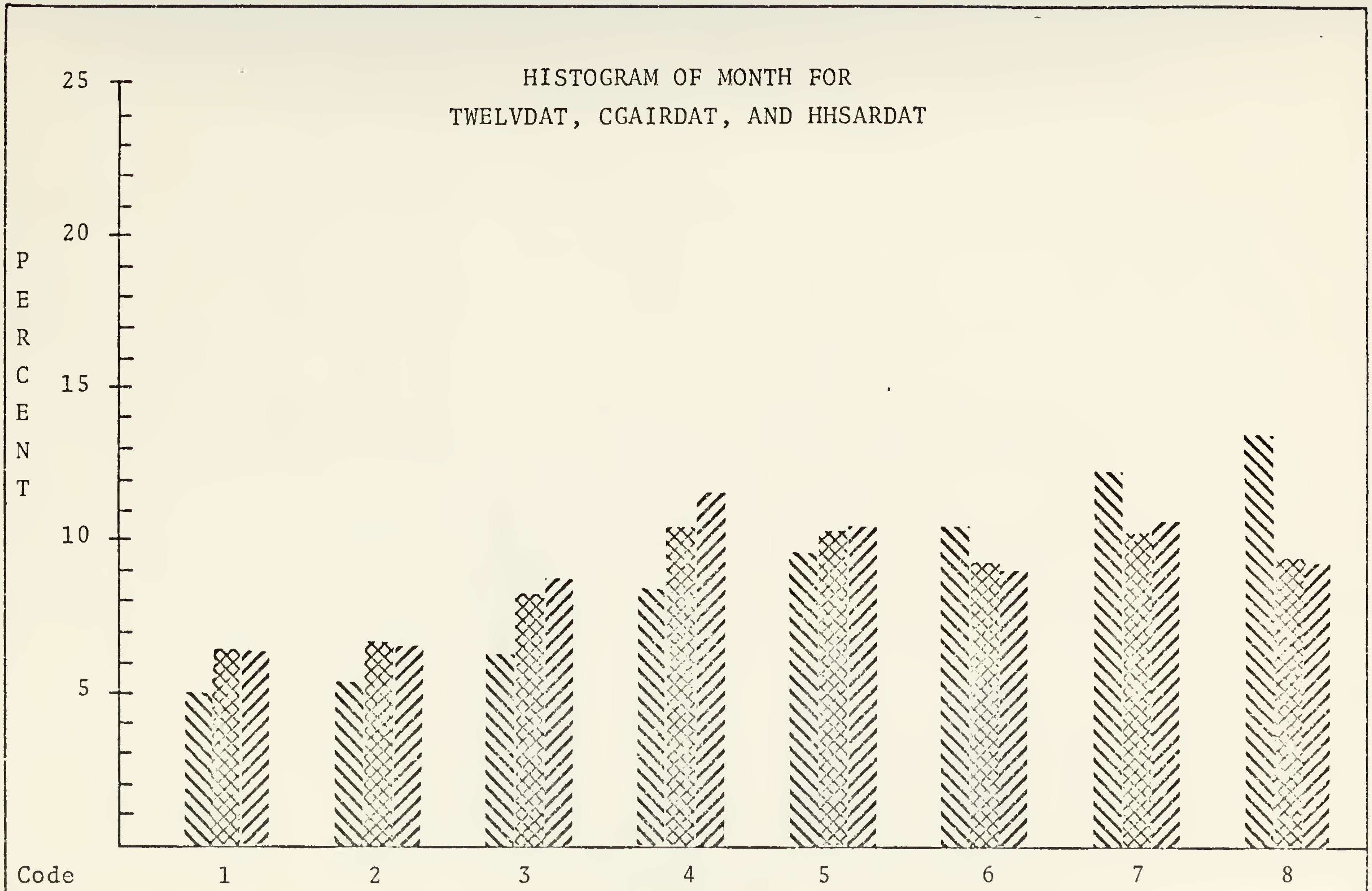

HISTOGRAM OF MONTH FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT
PERCENT
25
20
15
10
5
Code
1
2
3
4
5
6
7
8

FIGURE 1-A

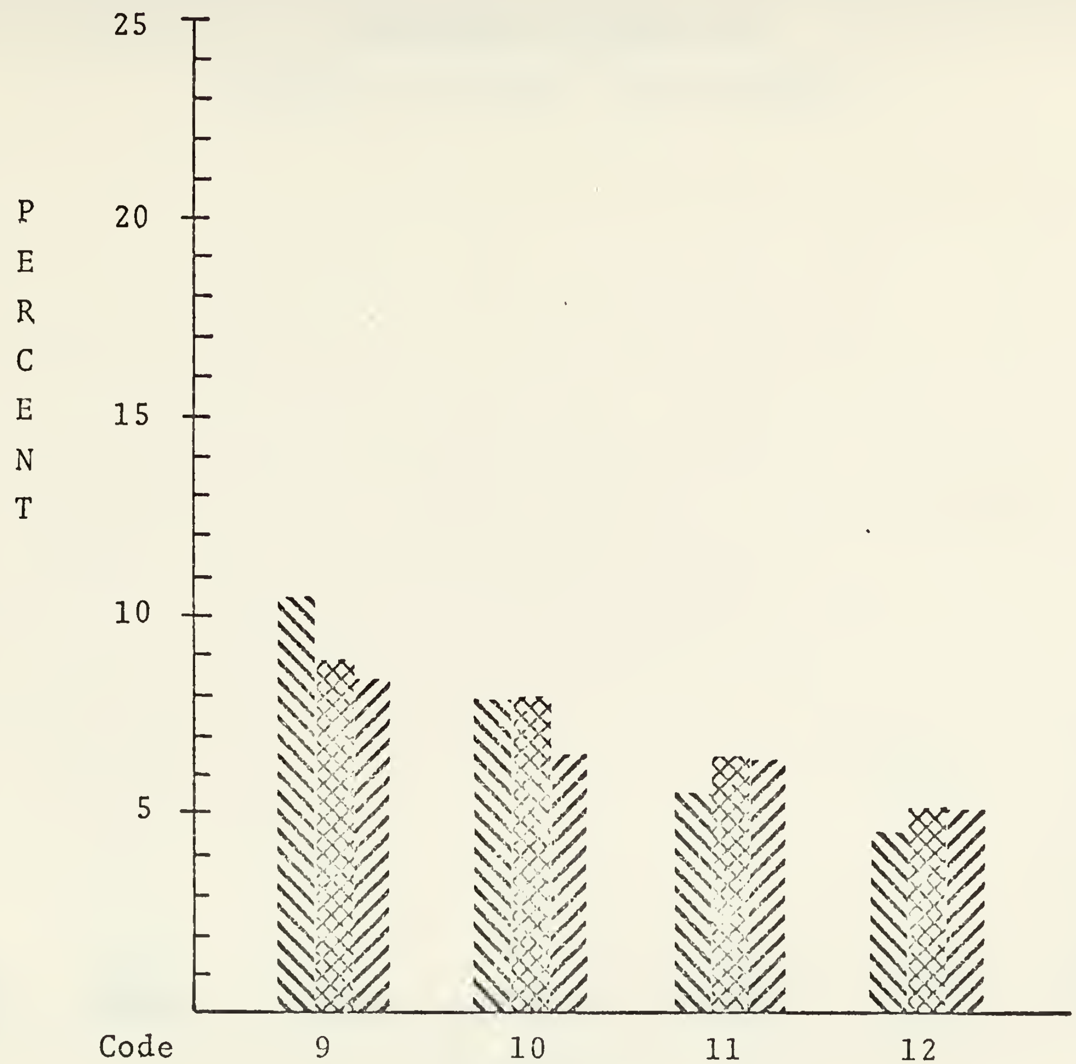


FIGURE 1-B

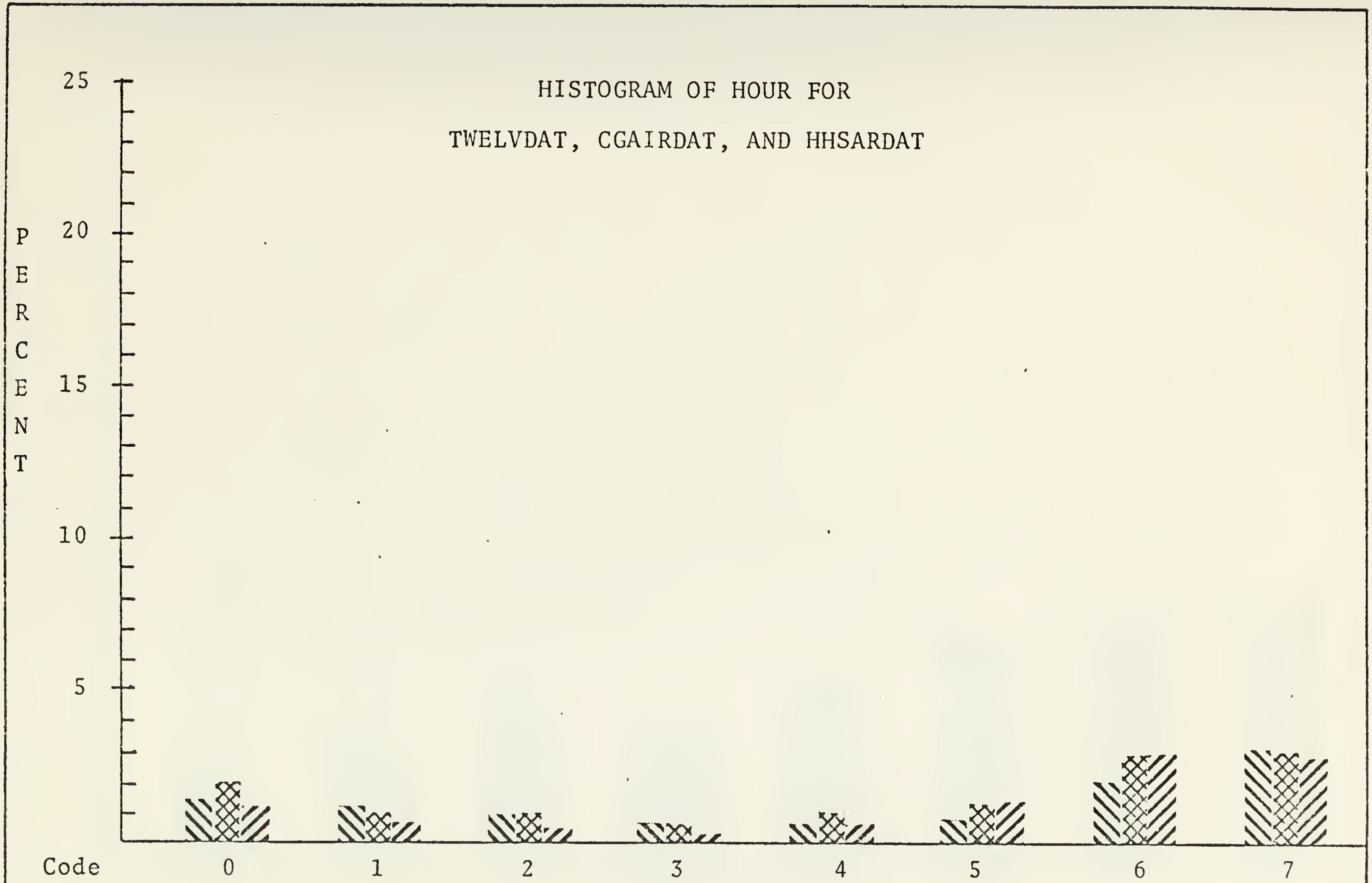

HISTOGRAM OF HOUR FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT
PERCENT
25
20
15
10
5
Code
0
1
2
3
4
5
6
7
FIGURE 2-A

FIGURE 2-B

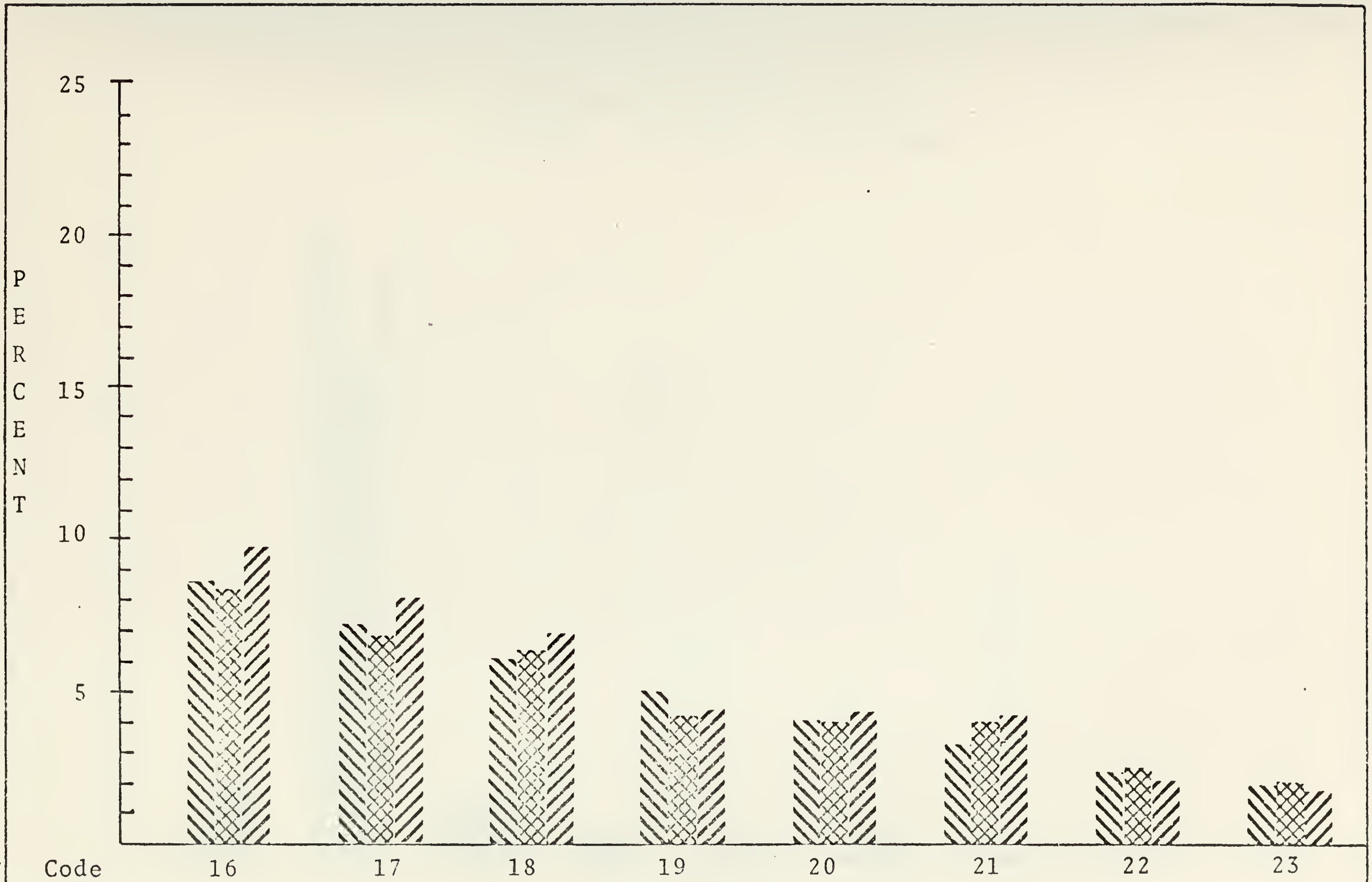


FIGURE 2-C

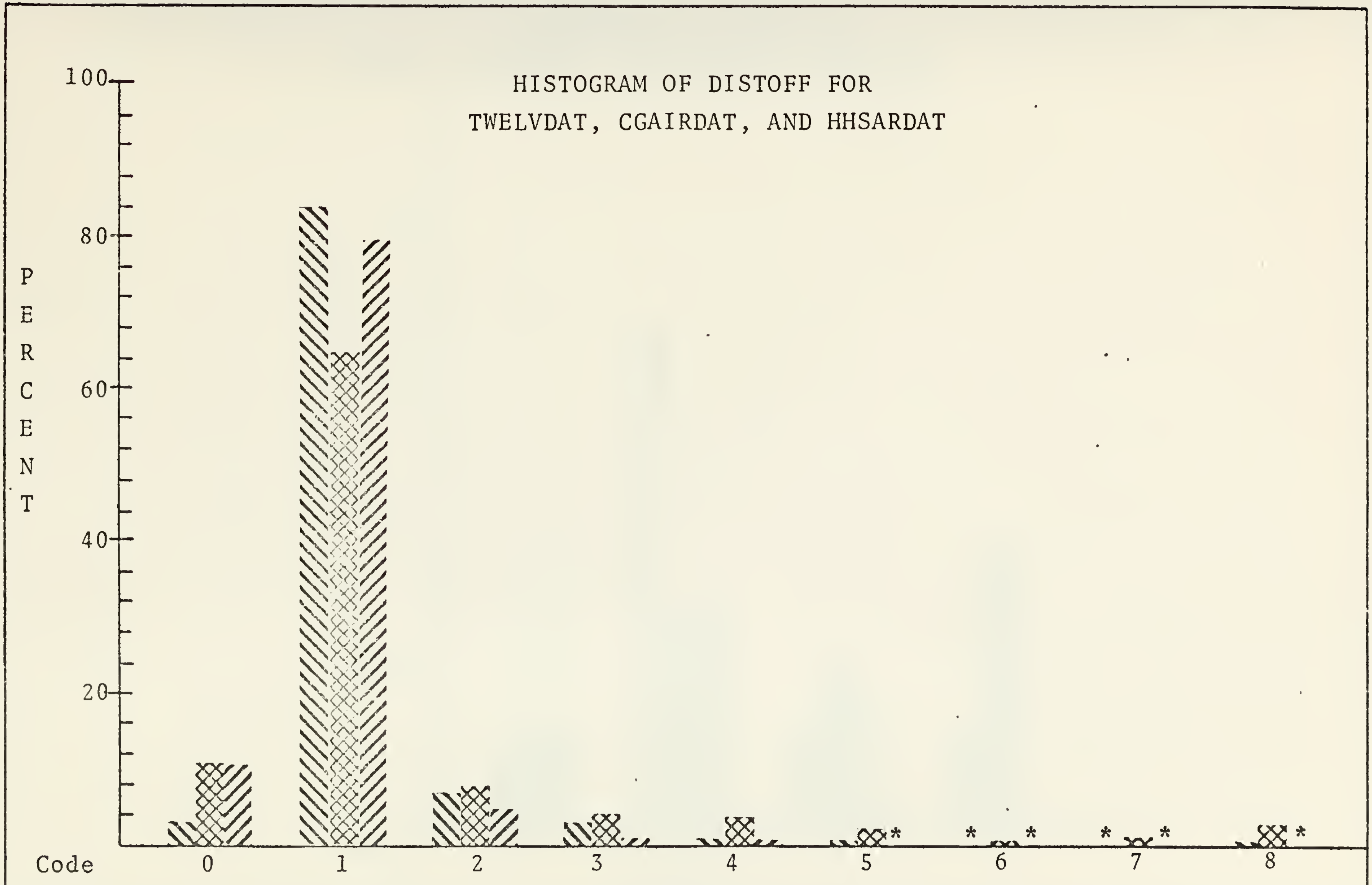

HISTOGRAM OF DISTOFF FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT
PERCENT
100
80
60
40
20
Code
0
1
2
3
4
5
6
7
8

FIGURE 3

HISTOGRAM OF SEVPER FOR
TWELVDAT, CGAIRDAT AND HHSARDAT

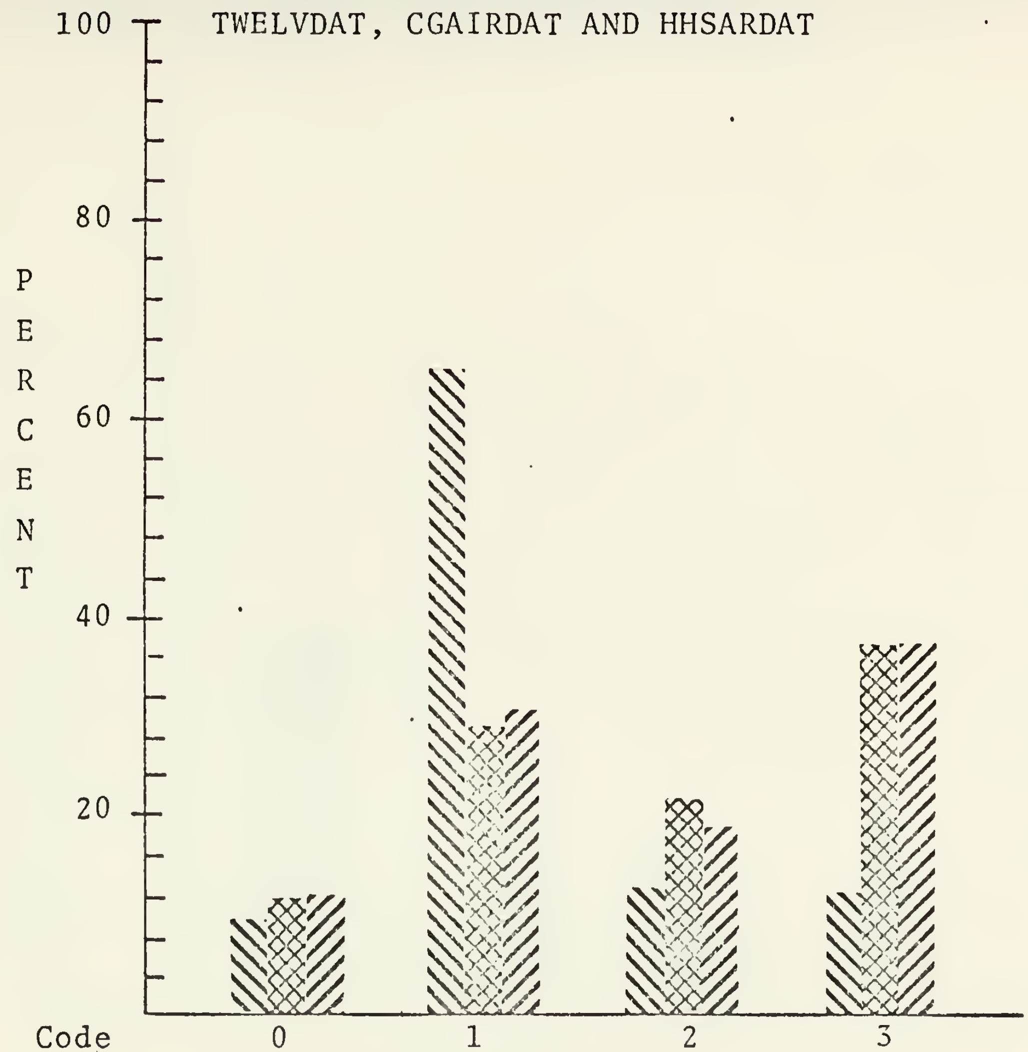


FIGURE 4

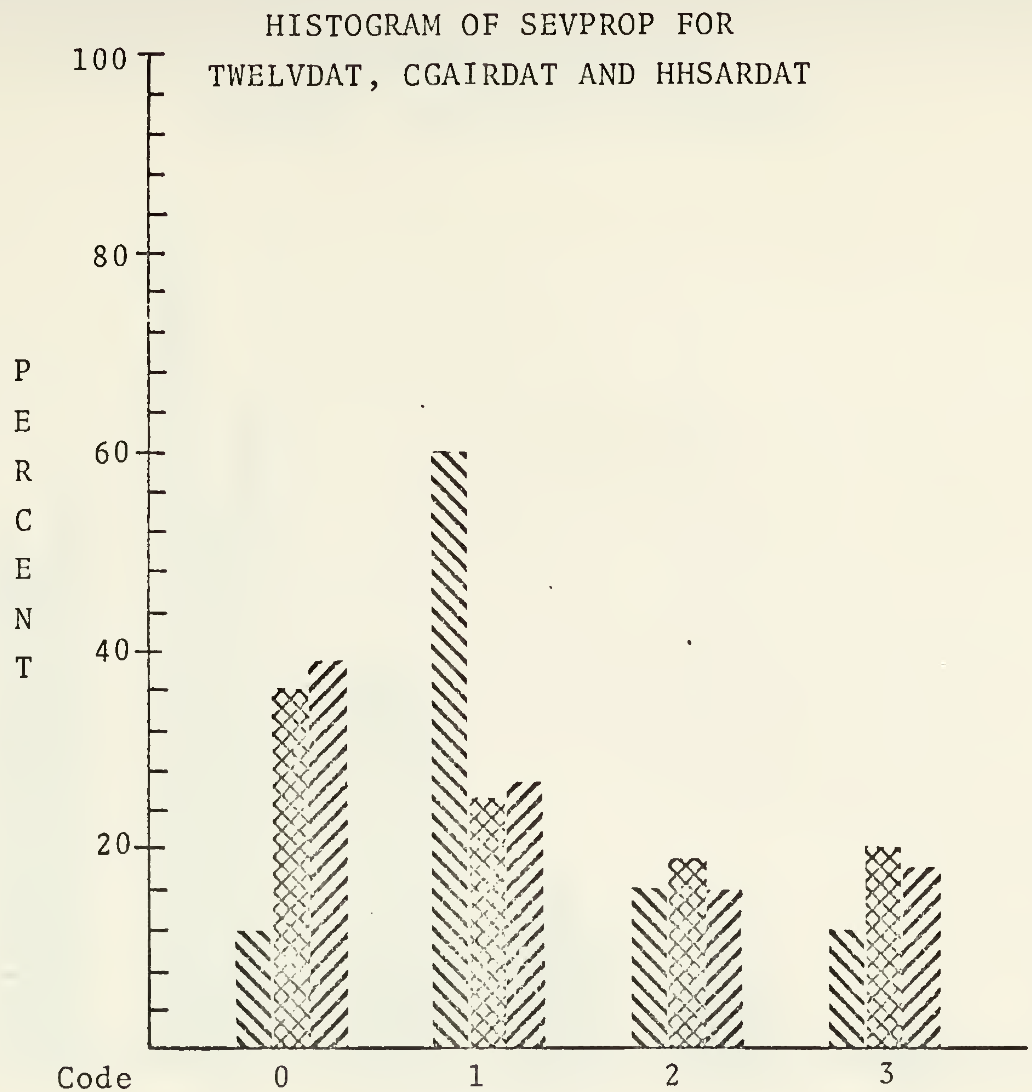

HISTOGRAM OF SEVPROP FOR
TWELVDAT, CGAIRDAT AND HHSARDAT
100
80
60
40
20
PERCENT
Code
0
1
2
3

FIGURE 5

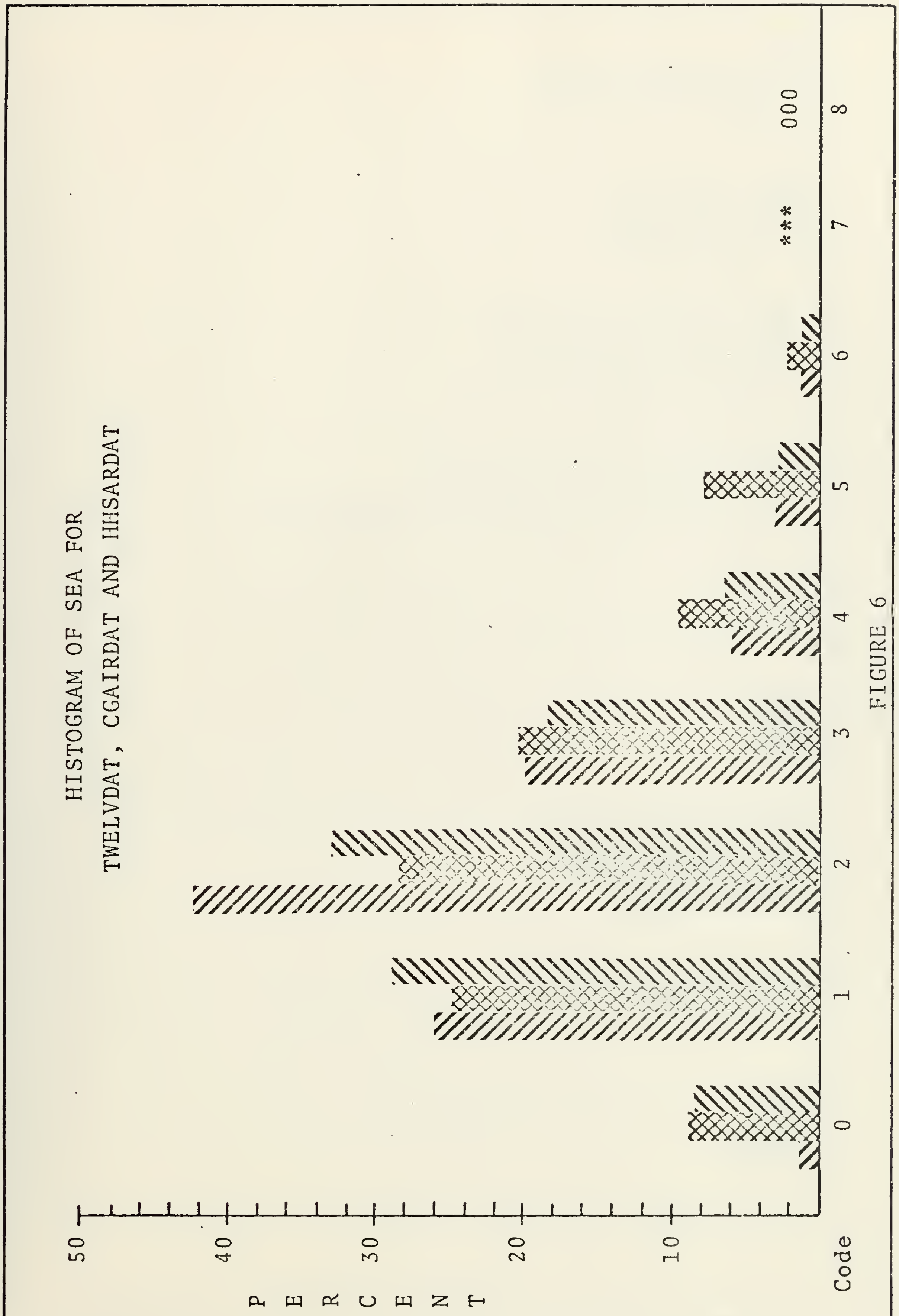

HISTOGRAM OF SEA FOR
TWELVDAT, CGAIRDAT AND HHSARDAT
P E R C E N T
50
40
30
20
10
Code
0
1
2
3
4
5
6
7
8
***
000

FIGURE 6

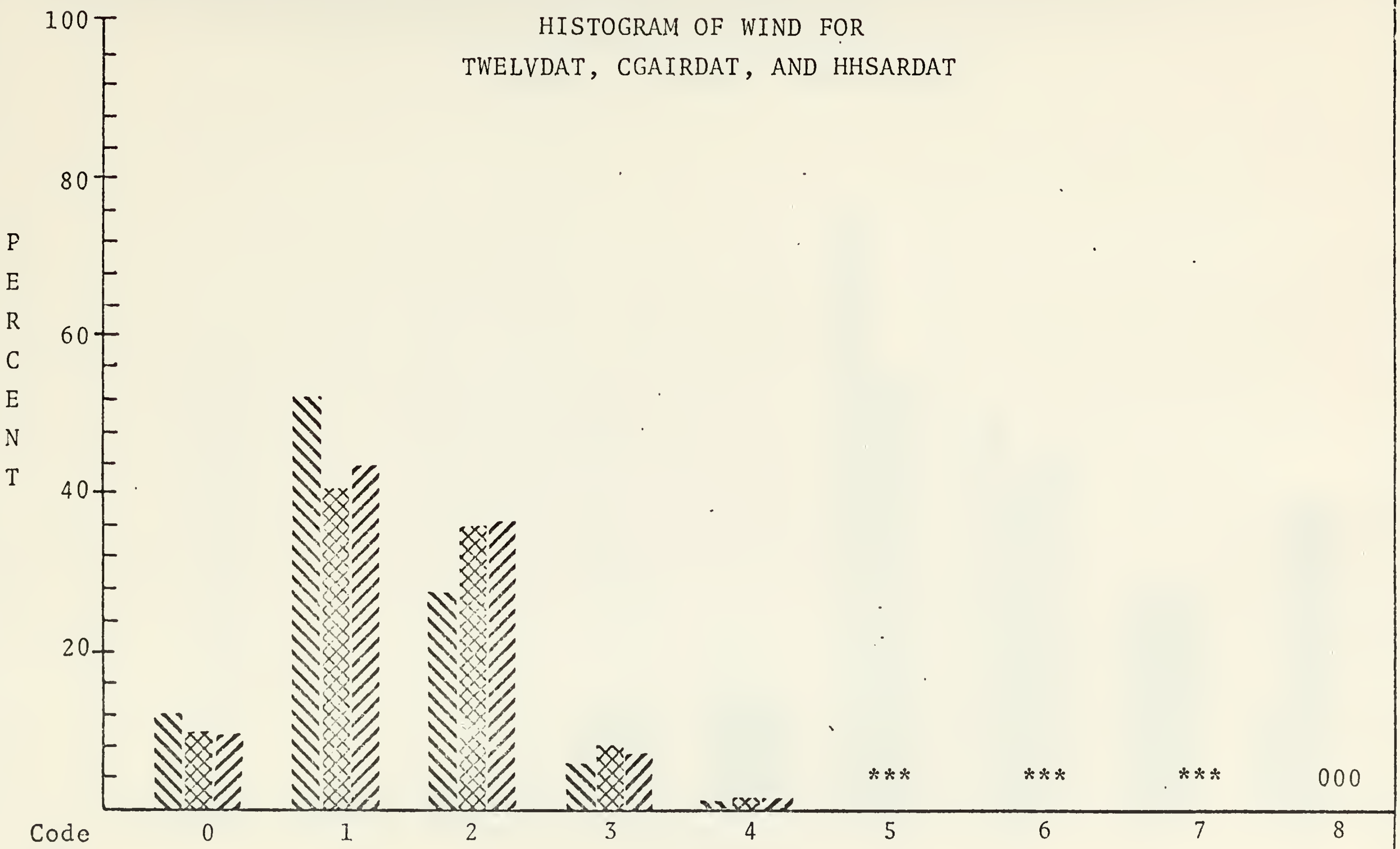

HISTOGRAM OF WIND FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT
100
80
60
40
20
PERCENT
Code
0
1
2
3
4
5
6
7
8
***
***
***
000

FIGURE 7

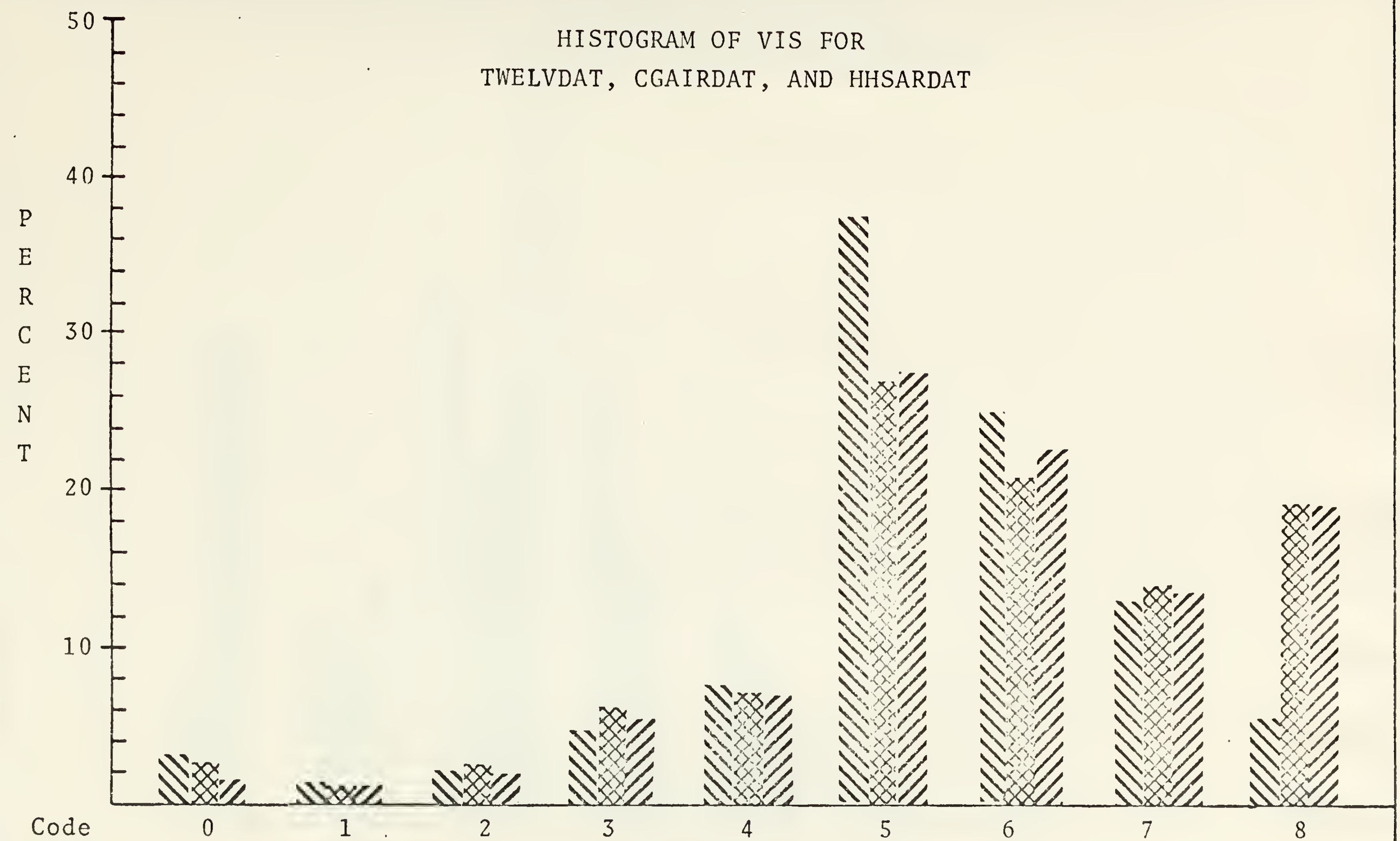

HISTOGRAM OF VIS FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT
50
40
30
20
10
P E R C E N T
Code
0
1
2
3
4
5
6
7
8

FIGURE 8

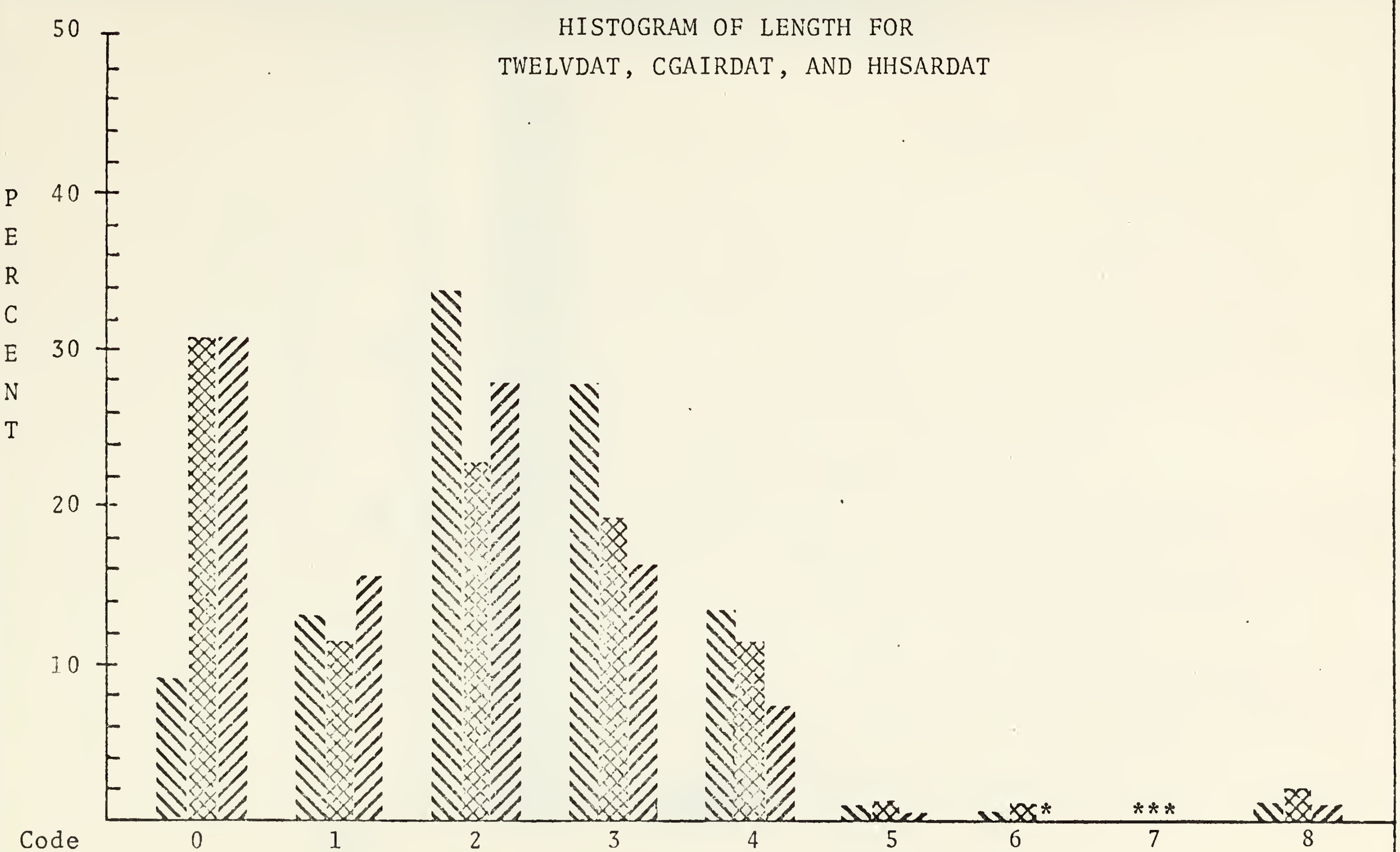

HISTOGRAM OF LENGTH FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT
PERCENT
50
40
30
20
10
Code
0
1
2
3
4
5
6
7
8
*
***

FIGURE 9

HISTOGRAM OF LOST FOR

TWELVDAT, CGAIRDAT, AND HHSARDAT

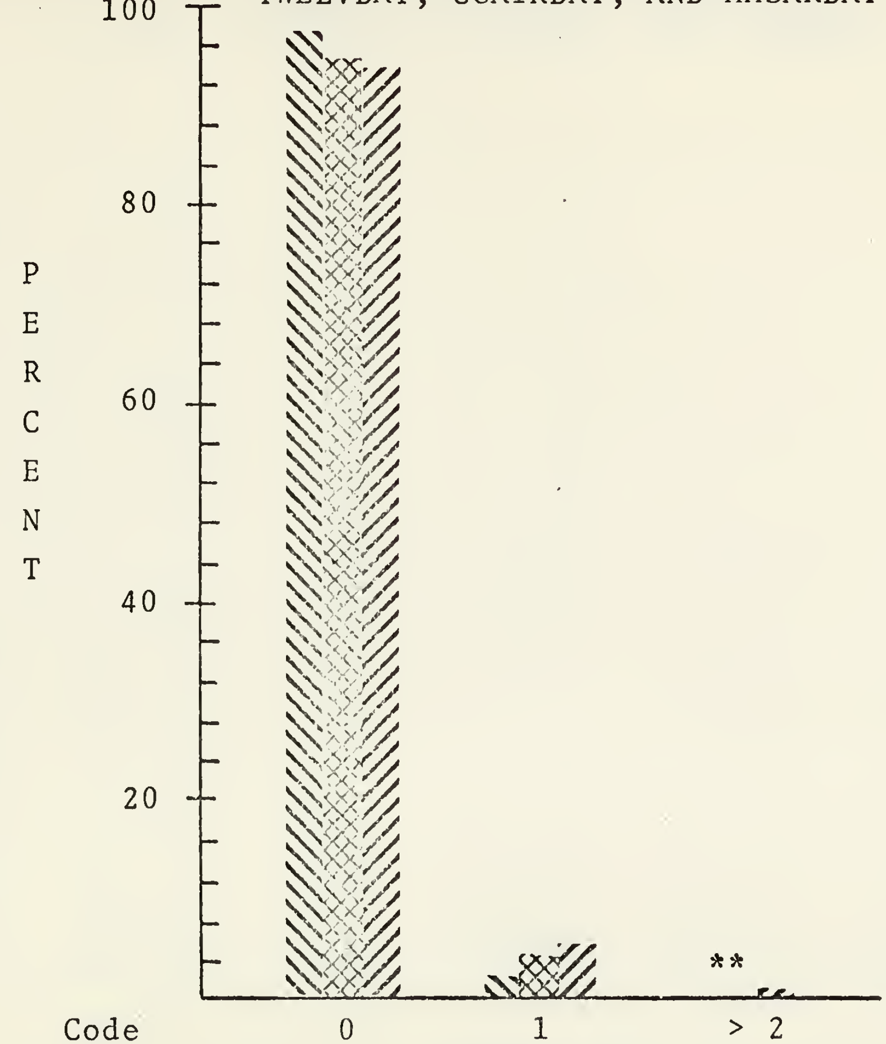


FIGURE 10

HISTOGRAM OF SAVED FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT

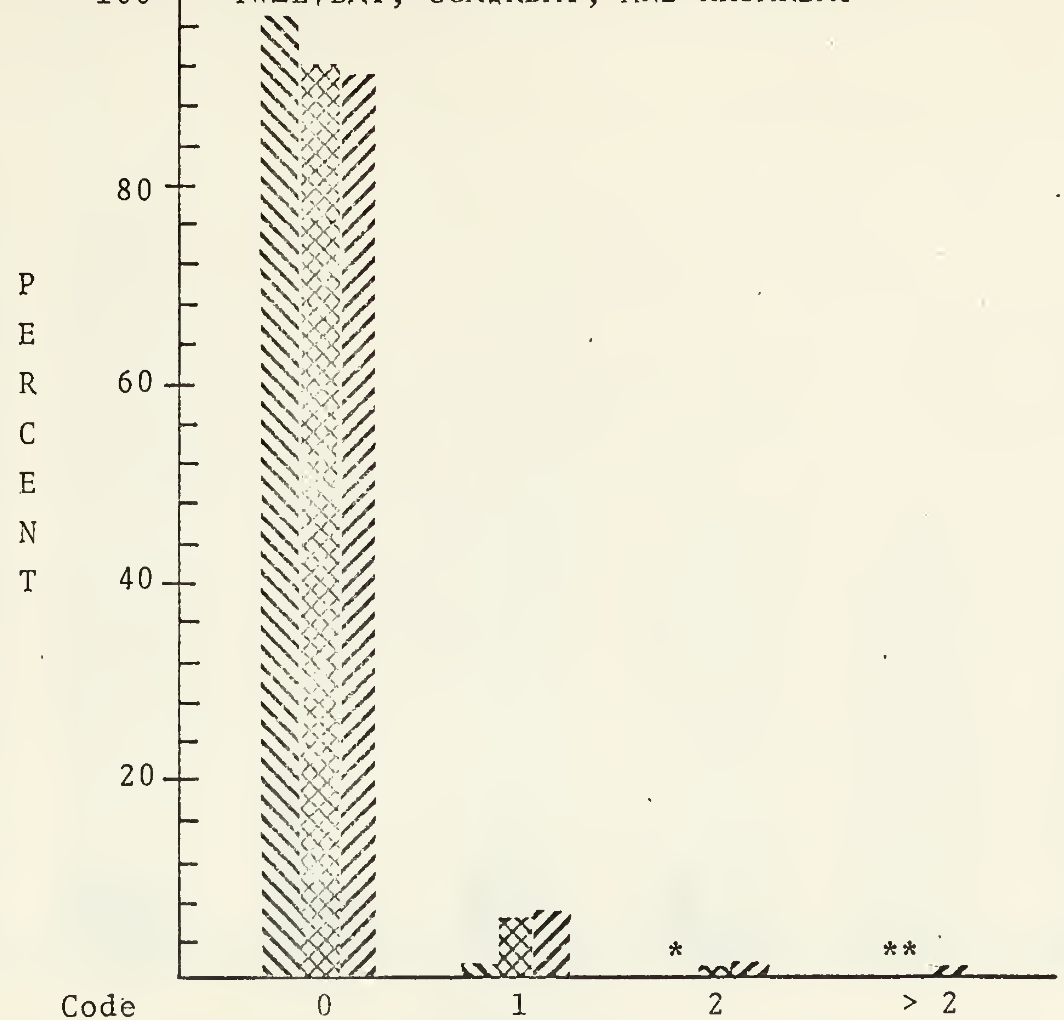


FIGURE 11

HISTOGRAM OF ASST FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT

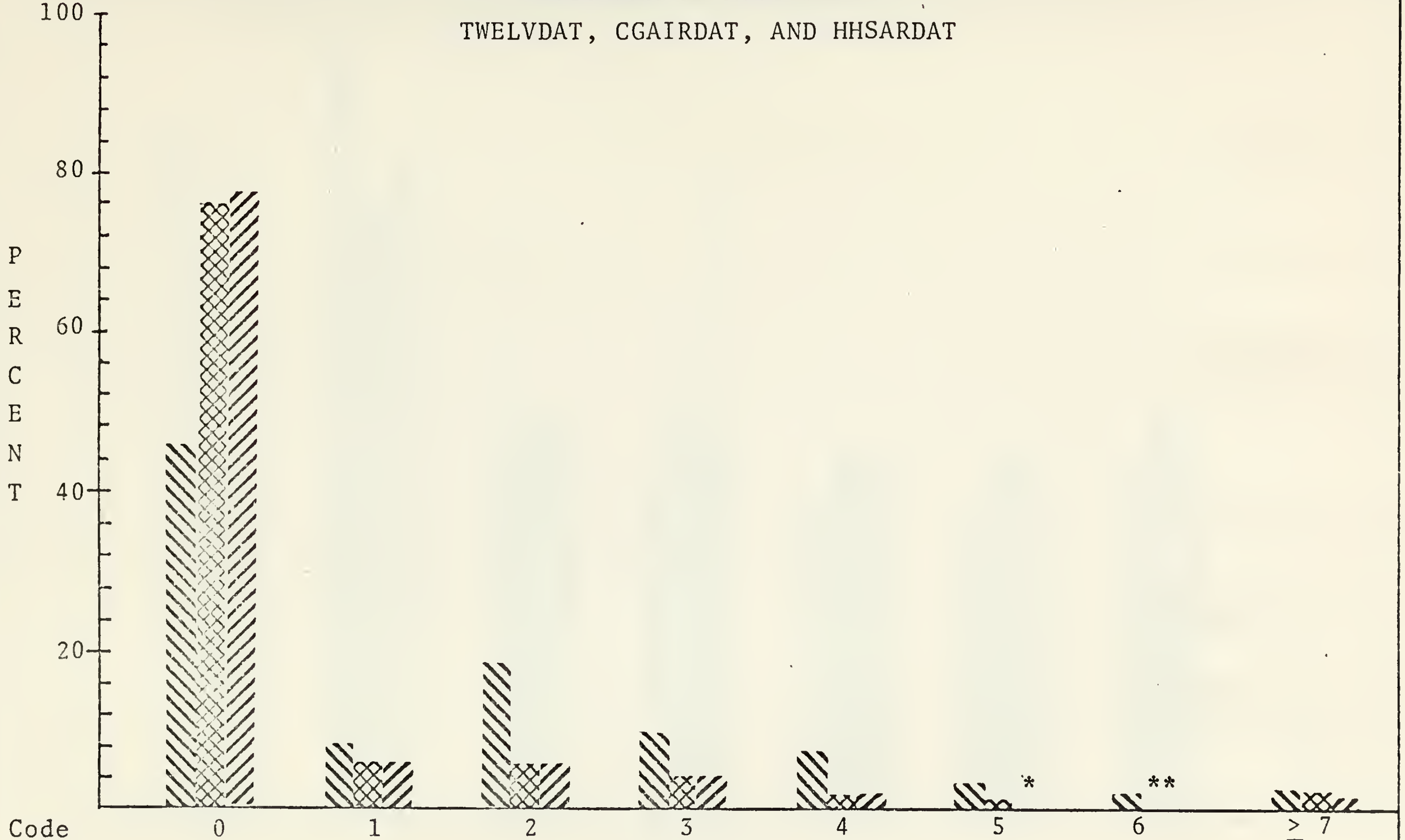
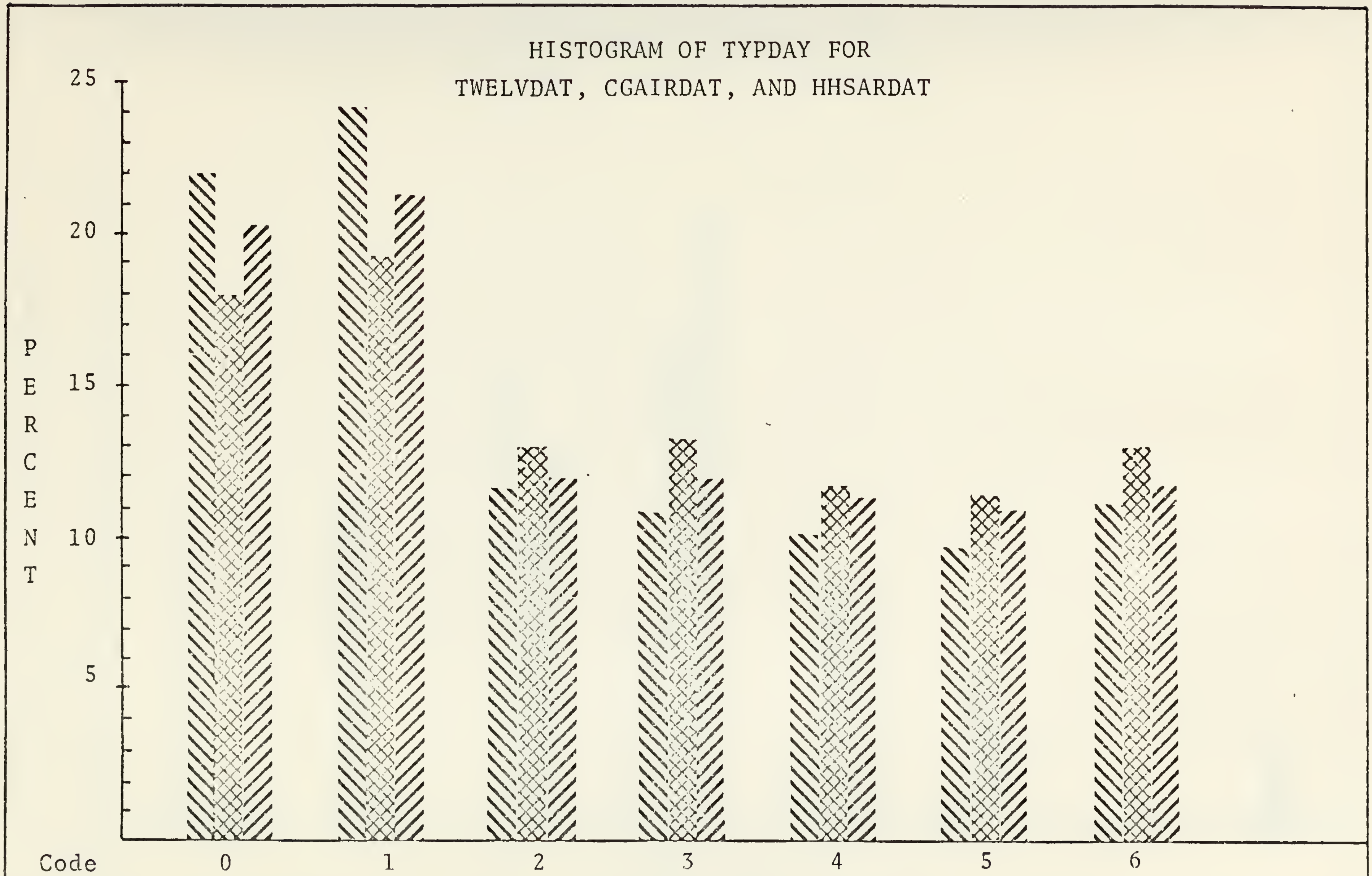


FIGURE 12



HISTOGRAM OF TYPDAY FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT
PERCENT
25
20
15
10
5
Code
0
1
2
3
4
5
6

FIGURE 13

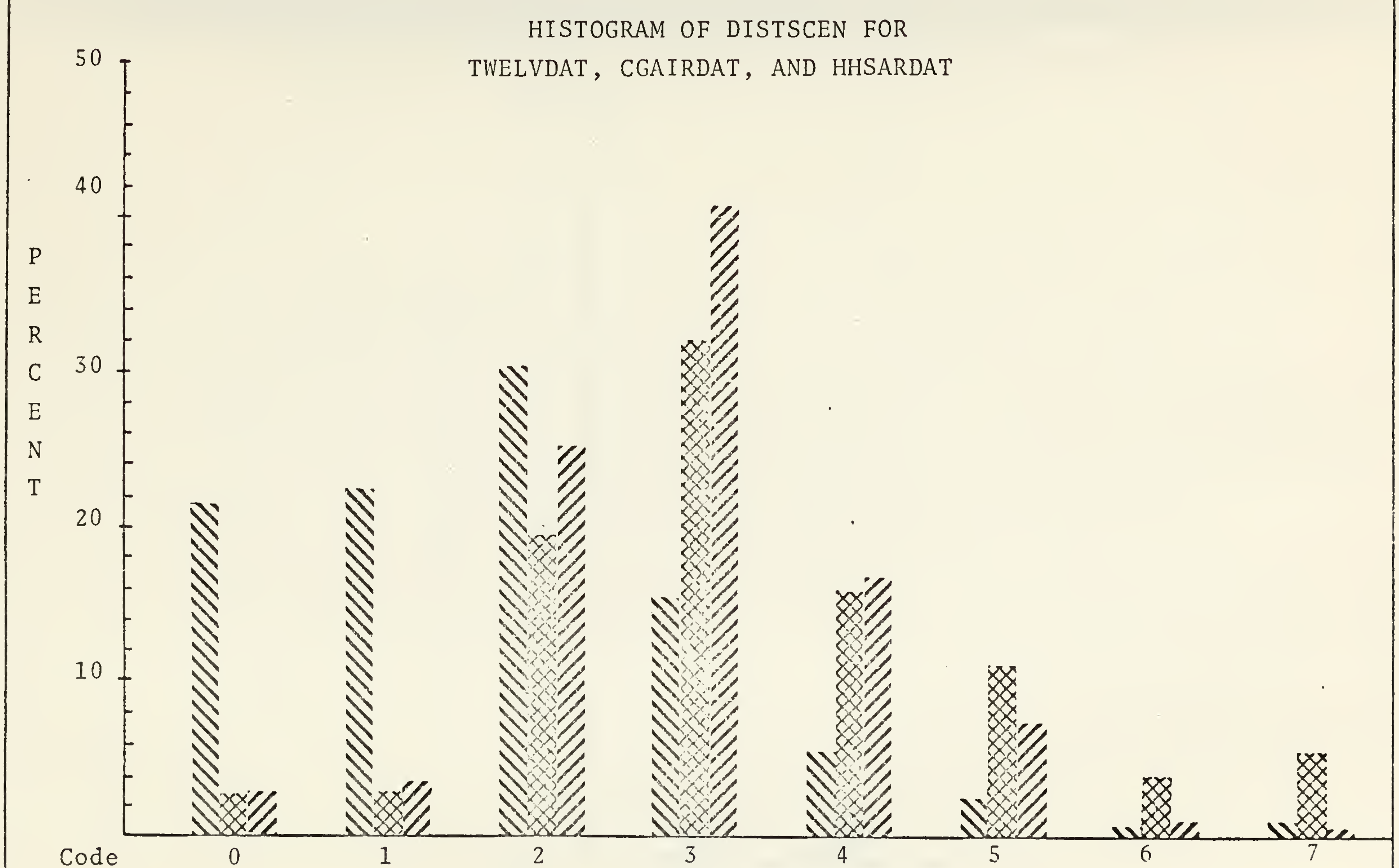

HISTOGRAM OF DISTSCEN FOR
TWELVDAT, CGAIRDAT, AND HHSARDAT
PERCENT
50
40
30
20
10
Code
0
1
2
3
4
5
6
7

FIGURE 14-A

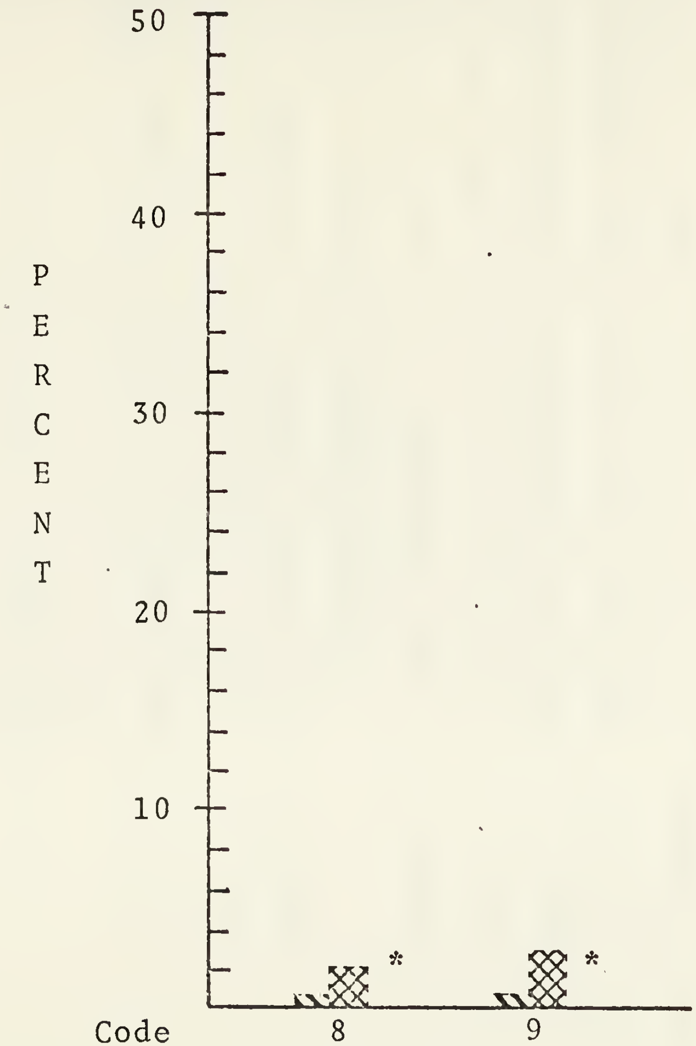


FIGURE 14-B

APPENDIX E

LINEAR CONTRASTS FROM ANALYSIS OF VARIANCE

This appendix contains the results of the linear contrasts performed in conjunction with the analysis of variance found in Chapter IV. The linear contrast is intended to isolate which means are causing rejection of the null hypothesis in the analysis of variance. Linear contrasts were performed on each of the three data sets (TWELVDAT, CGAIRDAT and HHSARDAT) when broken down into annual subsets. Since a linear contrast is meaningless when only two means are involved, contrasts were not performed on the comparisons of pairs of data sets. Following below is a description of Scheffee's method of linear contrasts.

By definition, a linear contrast, L, is a linear combination of some parameters $\beta_1, \beta_2, \ldots, \beta_k$ using weights which sum to zero. Thus for the parameter $\bar{Y} \cdot j$:

$$\hat{L} = \sum_{j=1}^{k} c_j \bar{Y}_{\cdot j} \quad \text{where} \quad \sum_{j=1}^{k} c_j = 0$$

$\hat{L}$ will have estimated variance

$$S_{\hat{L}}^2 = \hat{\sigma}^2 \sum_{j=1}^{k} \frac{c_j^2}{n_j} \quad \text{where} \quad \hat{\sigma}^2 = \frac{S_1}{N - k}$$

This test makes pairwise comparisons of all column means, checking the null hypothesis that:

$$H_o : \mu_{\cdot n} - \mu_{\cdot m} = 0, \ 1 \leq n, m \leq k, \ n \neq m$$

A 100(1-α) percent confidence interval for the linear contrast, L, is given by:

$$\hat{L} \neq S_{\hat{L}} \sqrt{(k-1)\ F_{\alpha;\ k-1,\ N-k}}$$

Thus the null hypothesis will be accepted if:

$$\hat{L} - S_{\hat{L}} \sqrt{(k-1)\ F_{\alpha;\ k-1,\ N-k}} \leq 0 \leq \hat{L} + S_{\hat{L}} \sqrt{(k-1)\ F_{\alpha;\ k-1,\ N-k}}$$

The X's in the tables indicate that the null hypothesis was rejected for the pair of years indicated, and that the two means are significantly different.

TABLE XVII

LINEAR CONTRASTS, TWELVDAT

	1,2	1,3	1,4	2,3	2,4	3,4
MONTH	XXX	XXX	XXX			
DISTOFF		XXX	XXX		XXX	
SEVPER	XXX		XXX	XXX		XXX
SEVPROP						
SEA			XXX			
WIND	XXX			XXX		XXX
VIS.						
LENGTH		XXX	XXX	XXX		
ASST			XXX			
TYPDAY		XXX	XXX			

TABLE XVIII

LINEAR CONTRASTS, CGAIRDAT

	1,2	1,3	1,4	2,3	2,4	3,4
MONTH						
SEVPER		XXX	XXX	XXX		
SEA						
LENGTH				XXX		
SAVED		XXX				
DISTSCEN		XXX		XXX		

TABLE XIX

LINEAR CONTRASTS, HHSARDAT

	1,3	1,3	1,4	2,3	2,4	3,4
HOUR						
DISTOFF		XXX		XXX		
SEVPER		XXX		XXX		XXX
LENGTH		XXX		XXX		XXX
ASST			XXX			
DISTSCEN		XXX		XXX	XXX	

APPENDIX F

SUMMARY OF T TEST RESULTS

This appendix contains the results of the student's t tests which were used to check for equality between the means for various sets of distances to scene from SFRAN and HAM. Table XX below depicts these results and provides references back to the tables containing the applicable distance means. In all instances except part (7) and part (9), the critical t for a 95% confidence interval is 1.645. For parts (7) and (9) the critical t varies between 1.645 and 1.670 with each separate entry.

TABLE XX

SUMMARY OF T TEST RESULTS

	REFERENCE	T	RESULT
(1) FOR CGAIRDAT CASES	TABLE IX		
HC-130		0.341	H_o ACCEPTED
HU-16E		0.211	H_o ACCEPTED
All HH-52A		1.189	H_o ACCEPTED
(2) FOR CGAIRDAT SORTIES	TABLE IX		
HC-130		0.350	H_o ACCEPTED
HU-16E		0.174	H_o ACCEPTED
All HH-52A		1.077	H_o ACCEPTED
(3) FOR HELIDAT CASES	TABLE XIII	7.096	H_o REJECTED
(4) FOR HELIDAT SORTIES	TABLE XIII	9.370	H_o REJECTED
(5) FOR HELIDAT CASES BY YEAR	TABLE XIV		
FY-71		2.822	H_o REJECTED
FY-72		3.589	H_o REJECTED
FY-73		4.156	H_o REJECTED
FY-74		3.521	H_o REJECTED

	REFERENCE	T	RESULT
(6) FOR HELIDAT SEVPER BY DISTANCE (CASES)	TABLE XV		
SEVPER CODE 0		3.986	H_o REJECTED
SEVPER CODE 1		4.288	H_o REJECTED
SEVPER CODE 2		2.411	H_o REJECTED
SEVPER CODE 3		2.892	H_o REJECTED
(7) FOR HELIDAT SEVPER BY DISTANCE BY YEAR	TABLE XVI		
FY-71 CASES			
SEVPER CODE 0		2.347	H_o REJECTED
SEVPER CODE 1		1.139	H_o ACCEPTED
SEVPER CODE 2		0.743	H_o ACCEPTED
SEVPER CODE 3		0.781	H_o ACCEPTED
FY-72 CASES			
SEVPER CODE 0		2.978	H_o REJECTED
SEVPER CODE 1		2.412	H_o REJECTED
SEVPER CODE 2		0.744	H_o ACCEPTED
SEVPER CODE 3		1.341	H_o ACCEPTED

	REFERENCE	T	RESULT
FY-73 CASES			
SEVPER CODE 0		0.927	H_o ACCEPTED
SEVPER CODE 1		3.004	H_o REJECTED
SEVPER CODE 2		2.669	H_o REJECTED
SEVPER CODE 3		2.276	H_o REJECTED
FY-74 CASES			
SEVPER CODE 0		2.874	H_o REJECTED
SEVPER CODE 1		2.169	H_o REJECTED
SEVPER CODE 2		1.925	H_o REJECTED
SEVPER CODE 3		1.173	H_o ACCEPTED
(8) FOR HELIDAT SEVPROP BY DISTANCE	TABLE XV		
SEVPROP CODE 0		3.442	H_o REJECTED
SEVPROP CODE 1		4.370	H_o REJECTED
SEVPROP CODE 2		2.990	H_o REJECTED
SEVPROP CODE 3		1.683	H_o REJECTED

	REFERENCE	T	RESULT
(9) FOR HELIDAT SEVPROP BY DISTANCE BY YEAR	TABLE XVI		
FY-71 CASES			
SEVPROP CODE 0		0.748	H_o ACCEPTED
SEVPROP CODE 1		1.535	H_o ACCEPTED
SEVPROP CODE 2		1.370	H_o ACCEPTED
SEVPROP CODE 3		1.073	H_o ACCEPTED
FY-72 CASES			
SEVPROP CODE 0		1.766	H_o REJECTED
SEVPROP CODE 1		2.481	H_o REJECTED
SEVPROP CODE 2		0.413	H_o ACCEPTED
SEVPROP CODE 3		0.502	H_o ACCEPTED
FY-73 CASES			
SEVPROP CODE 0		2.618	H_o REJECTED
SEVPROP CODE 1		2.899	H_o REJECTED
SEVPROP CODE 2		4.079	H_o REJECTED
SEVPROP CODE 3		0.861	H_o ACCEPTED

	REFERENCE	T	RESULT
FY-74 CASES			
SEVPROP CODE 0		1.719	H_o REJECTED
SEVPROP CODE 1		2.108	H_o REJECTED
SEVPROP CODE 2		1.443	H_o ACCEPTED
SEVPROP CODE 3		0.954	H_o ACCEPTED

BIBLIOGRAPHY

1. Bolch, B. W. and Huang, C. J., Multivariate Statistical Methods for Business and Economics, Prentice-Hall, 1974.

2. Commander, Coast Guard District Twelve, Twelfth Coast Guard District OPLAN, San Francisco, 1975.

3. Dixon, W. J. (ed.), Biomedical Computer Programs, University of California Press, 1973.

4. Fishman, G., Concepts and Methods in Discrete Event Digital Simulation, John Wiley and Sons, 1973.

5. Naval Postgraduate School, W. R. Church Computer Center Technical Note No. 0211-03, Plotting Package for NPS IBM 360/67, by Patricia Johnson, January 1974.

6. Naval Postgraduate School, W. R. Church Computer Center Technical Note No. 0211-08, Procedures for Converting 7-Track Magnetic Tapes to 9-Track Magnetic Tapes, February 1973.

7. Naval Postgraduate School, W. R. Church Computer Center Technical Note No. 0211-19, Directions for Using SPSS (Statistical Package for the Social Sciences), by G. P. Learmonth, March 1974.

8. Naval Postgraduate School, W. R. Church Computer Center Technical Note No. 0211-20, SNAP/IEDA Computing Package User's Manual, by Princeton University Department of Statistics, July 1972.

9. Naval Postgraduate School, W. R. Church Computer Center Technical Note No. 0211-22, Statistical Resources of the W. R. Church Computer Center, by G. P. Learmonth, March 1974.

10. Nie, N. H., Bent, D. H., and Hull, C. H., Statistical Package for the Social Sciences, McGraw-Hill, 1970.

11. United States Coast Guard, Air Operations Manual (CG-333), Washington, 1973.

12. United States Coast Guard, Aviation Plan Study Report (CG-380-2), April 1973.

13. United States Coast Guard, SAR Reports Manual (CG-372), Washington, 1969.

14. Walpole, R. E., Introduction to Statistics, 2d ed., MacMillan, 1974.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
2.	Library, Code 0212 Naval Postgraduate School Monterey, California 93940	2
3.	Department Chairman, Code 55 Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
4.	Asst Professor S. H. Parry, Code 55 Py Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
5.	CDR C. P. Gibfried, Code 55 Gf Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
6.	Commandant (G-OSR-2/73) United States Coast Guard Washington, D. C. 20591	2
7.	Commandant (G-PTP/72) United States Coast Guard Washington, D. C. 20591	2
8.	Commander (op) Coast Guard Pacific Area 630 Sansome Street San Francisco, California 94126	2
9.	Commander (o) Twelfth Coast Guard District 630 Sansome Street San Francisco, California 94126	2

10. LCDR Jean Andrew Snyder, USCG 1
USCG ALERT (WMEC-630)
Cape May, New Jersey 08204

Thesis
S66276
c.2

161433

Snyder
The operational impact of relocating Coast Guard Air Station San Francisco to Hamilton Air Force Base.

85-97
98-110
115-115